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MACHINERY'S DATA SHEETS

REVISED AND RE-ARRANGED IN LIBRARY FORM

No. 20

Wiring Diagrams
Heating and Ventilation
Miscellaneous Tables

PRICE 25 CENTS

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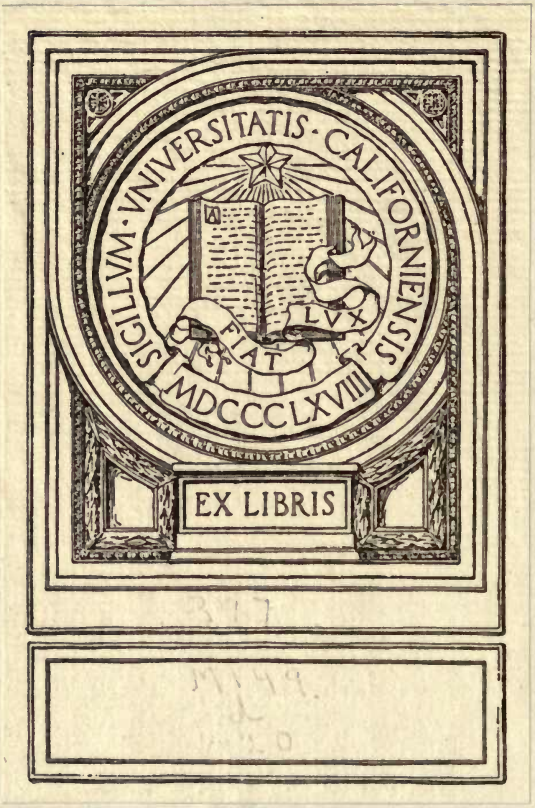
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MACHINERY'S DATA SHEET SERIES

COMPILED FROM MACHINERY'S MONTHLY DATA SHEETS AND ARRANGED WITH EXPLANATORY NOTES

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In the following pages are compiled a number of concise tables and diagrams relating to electric motors, copper wire and cables, heating and ventilation, mechanical brakes, miscellaneous machine details, drafting-room conventions, and conversion tables from the English to the metric system, and *vice versa*. These tables are carefully selected from MACHINERY'S monthly Data Sheets, issued as supplements to the Engineering and Railway editions of MACHINERY since September, 1898. Several additional tables are also included which are published here for the first time.

In order to enhance the value of the tables, brief explanatory notes have been provided wherever necessary. In some of these notes references are made to articles which have appeared in MACHINERY and to matter published in MACHINERY'S Reference Series, giving additional information on the subject. These references will be of considerable value to readers who wish to make a more thorough study of the subject. In a note at the foot of the tables reference is made to the page on which the explanatory note relating to the table appears.

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WIRING DIAGRAMS, HEATING AND VENTILATION, ETC.

Motor Wiring Diagrams

On pages 4 to 7, inclusive, are given nineteen motor wiring diagrams for both direct current and alternating current motors. Beneath the diagrams explanatory notes are provided, giving the required additional information. [MACHINERY, September, 1906, Diseases of Dynamos and Motors; March, 1910, The Operation and Care of Small Electrical Machinery; MACHINERY'S Reference Series No. 34, Care and Repair of Dynamos and Motors.]

Dimensions and Carrying Capacity of Round Copper Wire

On pages 8 and 9 two tables are given relating to the dimensions, carrying capacity, weight and resistance of round copper wire.

On page 10 a table is given of rubber covered cables giving the actual cross-sectional area in circular mils, diameter, diameter of drilled holes in terminals, and maximum carrying capacity.

Page 11 gives current densities for various kinds of contacts for different materials. It also gives the areas of cross-section required per ampere.

Speed, Horsepower and Capacity of Centrifugal Fans

On pages 12 and 13 tables are given of the relation between speed, horsepower, and capacity of centrifugal fans. The two columns to the left give the dimensions of the fan, and the body gives the required revolutions per minute, the horsepower, and the volume of air discharged into free air per minute at pressures varying from 1/4 ounce to 1 ounce. The tables given apply only to fans discharging into free air. When connected with a series of ventilating ducts, the effect is the same as that of partially closing the fan outlet, and thus reducing the volume and horsepower in practically the same proportion. In the case of schools, churches, etc., where shallow heaters are used, and the flue velocities do not exceed 800 to 1000 feet per minute, the volume and horsepower as found in the tables for any given speed should be reduced about 20 per cent. In shops and factories where deep heaters are used and flue velocities run up to 1800 to 2000 feet per minute, there should be a reduction of about 40 per cent.

The volume of air supplied to a building is usually based on the number of occupants. The table below represents good modern practice and may be used with satisfactory results.

Air Supply per Occupant	Cubic Feet per Hour
Hospitals	4000 to 6000
High schools	3000
Grammar schools	2400
Theatres and halls	1500
Churches	1200

[MACHINERY, October, November and December, 1905, Centrifugal and Disk Fans; June, 1908, Calculation of Fans and Heaters; MACHINERY'S Reference Series No. 39, Fans, Ventilation and Heating.]

Volume, Pressure and Horsepower of Blowers

The tables and diagrams on pages 15, 17, 18 and 19, compiled by the B. F. Sturtevant Company, Hyde Park, Mass.,

(Continued on page 14.)

TYPICAL DIRECT CURRENT MOTOR WIRING DIAGRAMS—I

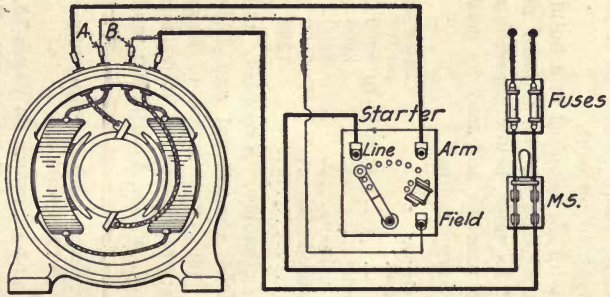


Diagram 1—To Reverse Rotation Interchange Connections A B.

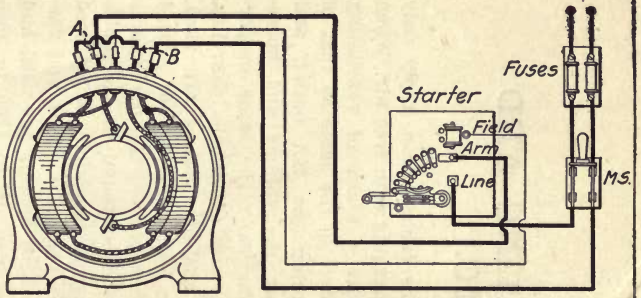


Diagram 2—To Reverse Rotation Interchange Connections A B.

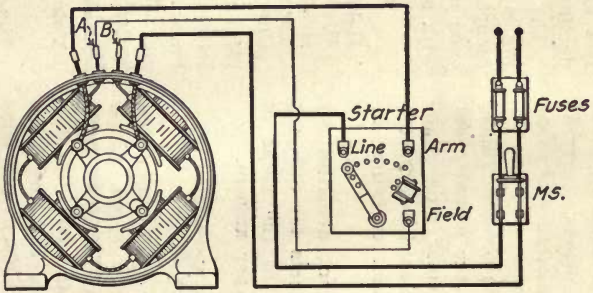


Diagram 3—To Reverse Rotation Interchange Connections A B.

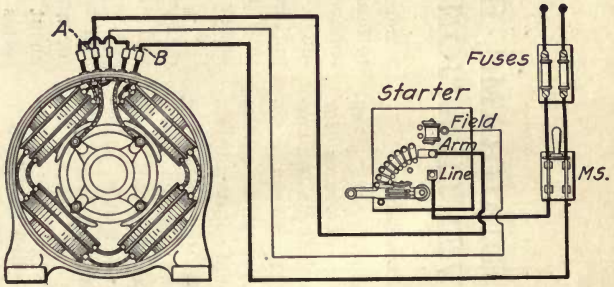


Diagram 4—To Reverse Rotation Interchange Connections A B.

Connections Between Motor and Line for Two- and Four-Pole Direct-Current Single Speed Uni-Directional Motors.

Diagrams 1 and 3 are for shunt wound, and 2 and 4 for compound wound machines. Main switch MS is shown closed, and lever of starter is in the stop position. Fuses can be connected between main line and MS, as shown, or placed below MS.

To start motor, close MS, and then swing starter lever slowly around as far as it will go.

To stop motor, open MS, and starter lever will fly back to stop position; if it does not, move it back before starting again.

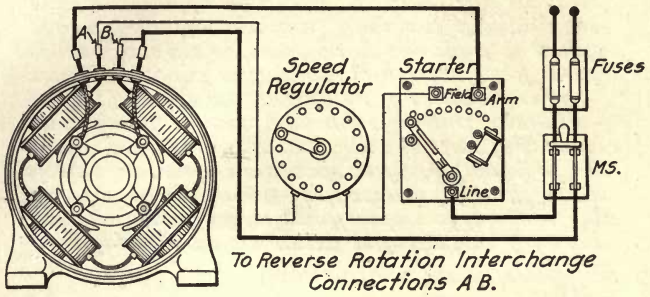


Diagram 5- Shunt Motor.

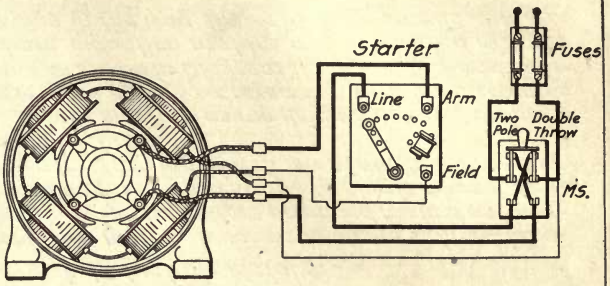


Diagram 7- Shunt Motor.

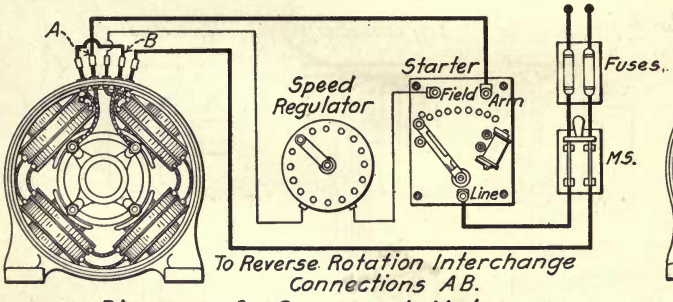


Diagram 6- Compound Motor.

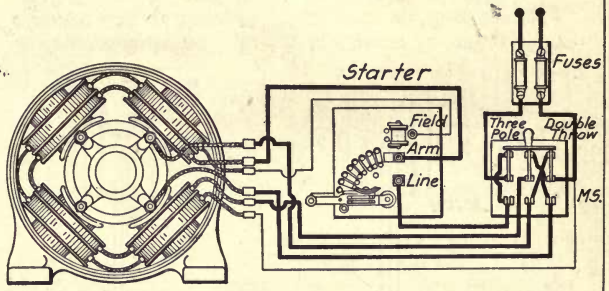


Diagram 8- Compound Motor.

Diagrams 5 and 6 show connections for variable speed direct-current motors. To change velocity, turn switch lever of speed regulator until desired speed is obtained.

Diagrams 7 and 8 show connections for motors arranged to be reversed at will. The reversing is accomplished by using a reversing main switch. A simple motor starter is shown is these diagrams.

The starters are also made combined with a speed regulator, a reversing switch, or both. If the starter is combined with a speed regulator, connections will be as in Diagrams 1 to 4. If combined with a reversing switch, connections will be as in Diagram 3 for shunt motors, and as in Diagram 4 for compound machines, with the additions of two more wires running from the starter to the motor.

TYPICAL ALTERNATING CURRENT INDUCTION MOTOR WIRING DIAGRAMS—I

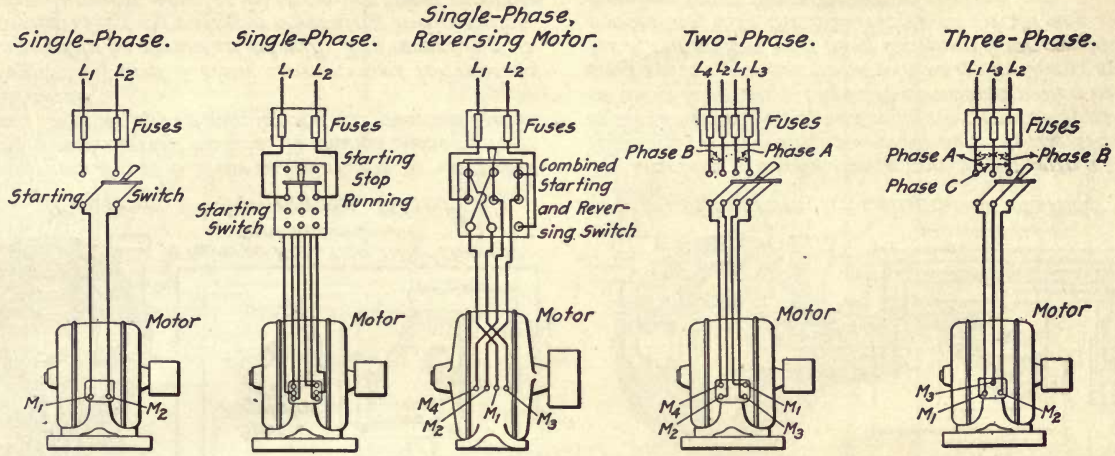


Diagram 9. Diagram 10. Diagram 11.

To Reverse Rotation Interchange Connections M_2 and M_4, or M_1 and M_3.

Diagram 12.

To Reverse Rotation Interchange any Two Connections to M_1 M_2 M_3.

Diagram 13.

Connections for Alternating Current Induction Motors.

Single-phase motors are not self-starting. Diagram 9 shows connections for small motors of this type. They are started by giving the belt a few quick pulls. Large single-phase motors are made self-starting by acting as two-or three-phase machines in starting; when up to speed, connections are changed to single-phase. They are also arranged to start as repulsion motors, and when running at nearly full speed, connections are automatically changed to single-phase induction motors. Diagram 9 shows connections for large motor arranged to start as repulsion motor. Diagram 10 shows connections for single-phase motors arranged to start as three-phase motors. To change to single-phase, move down the starting switch lever (which is thrown upward to start).

Motors starting as repulsion machines are made reversible by using a reversing switch, with connections as shown in Diagram 11. Small two-and three-phase induction motors are connected with the mains in the way shown in Diagrams 12 and 13.

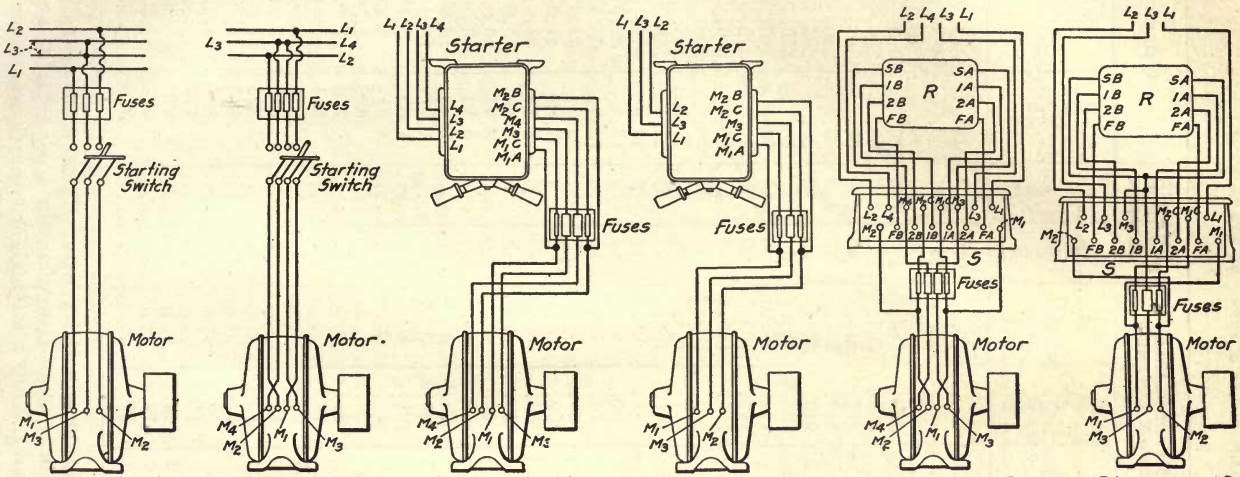


Diagram 14. Diagram 15. Diagram 16. Diagram 17. Diagram 18. Diagram 19.

When a three terminal motor is connected with four main wires, connections are made as shown in Diagram 14, one of the motor terminals being connected with two line wires.

When the motor has four terminals and three line wires, connections are made as in Diagram 15, two motor terminals being connected with one of the line wires. In medium size motors, regulator and starting switch are combined in one, the connections with the motor and line being as shown in Diagram 16 for two-phase, and in Diagram 17 for three-phase motors. When the motor is large, regulator and starting box are made separate, and are located as near to each other as possible. Connections are made between the mains, the starter, the regulator, and the motor. These connections are made as shown in Diagram 18, for two-phase motors, and in Diagram 19 for three-phase motors. The starting switch is marked "S" and the regulator "R".

ROUND COPPER WIRE.

	Dia. Mils Bare.	Area, Cross Section.		Diameter Mils, Cotton Covered.			Capacity (Chi. Code) Amperes.		Weight (Bare).		
		C. M.	Square M.	Single.	Double.	Triple.	Concealed.	Open.	Lbs. per 1000 feet.	Lbs. per Mile.	Feet per Pound.
0000	460.	212000.	166000.	.....	.....	.....	210	312	641.	3385.	1.560
000	410.	167805.	132000.	.....	.....	.....	177	262	509.	2688.	1.965
00	365.	133079.	105000.	.....	.....	.....	150	220	403.	2128.	2.481
0	325.	105592.	83000.	.....	339.	343.	127	185	320.	1690.	3.125
1	289.	83694.	65600.	.....	303.	307.	107	156	253.	1336.	3.953
2	258.	66373.	52300.	.....	272.	276.	90	131	202.	1067.	4.951
3	229.	52634.	41200.	.....	242.	247.	76	110	159.	840.	6.289
4	204.	41742.	32700.	211.	216.	220.	65	92	126.	665.	7.937
5	182.	33102.	26000.	189.	194.	198.	54	77	100.	528.	10.00
6	162.	26251.	20600.	169.	174.	178.	46	65	79.5	420.	12.58
7	144.	20816.	16300.	151.	156.	160.	39	56	62.8	332.	15.92
8	129.	16509.	13100.	136.	141.	145.	33	46	50.4	266.	19.84
9	114.	13094.	10200.	121.	126.	130.	29	39	39.4	208.	25.38
10	102.	10381.	8180.	108.	112.	116.	24	32	31.5	166.	31.75
11	91.	8234.	6500.	97.	101.	105.	21	27	25.1	133.	39.84
12	81.	6530.	5160.	87.	91.	95.	17	23	19.9	105.	50.25
13	72.	5178.	4080.	78.	82.	86.	14	19	15.7	82.9	63.70
14	64.	4107.	3220.	70.	74.	78.	12	16	12.4	65.5	80.65
15	57.	3257.	2550.	63.	67.	71.	8	10	9.85	52.0	101.5
16	51.	2583.	2040.	56.	59.	63.	6	8	7.88	41.6	126.9
17	45.	2048.	1590.	50.	53.	57.	4	6	6.14	32.4	162.9
18	40.	1624.	1260.	45.	48.	52.	3	5	4.85	25.6	206.2
19	36.	1288.	1020.	40.	44.	48.	.....	.....	3.93	20.8	254.5
20	32.	1021.	806.	36.	40.	44.	.....	.....	3.10	16.4	322.6
21	28.5	810.	638.	32.5	36.5	40.5	.....	.....	2.46	13.0	465.1
22	25.5	642.	511.	29.5	33.5	37.5	.....	.....	1.97	10.4	507.6
23	23.	509.	416.	27.	31.	35.	.....	.....	1.60	8.45	625.0
24	20.	404.	314.	24.	28.	32.	.....	.....	1.21	6.39	826.4
25	18.	320.	254.	22.	26.	.....	.....	.....	.982	5.18	1018.
26	16.	254.	201.	20.	24.	.....	.....	.....	.776	4.10	1289.
27	14.	201.	154.	18.	22.	.....	.....	.....	.594	3.14	1684.
28	12.6	159.8	125.	16.6	20.6	.....	.....	.....	.481	2.54	2079.
29	11.	126.7	95.1	15.	19.	.....	.....	.....	.367	1.94	2725.
30	10.	100.5	78.5	14.	18.	.....	.....	.....	.303	1.60	3300.
31	9.	79.7	63.7	13.	17.	.....	.....	.....	.245	1.29	4082.
32	8.	63.	50.3	12.	16.	.....	.....	.....	.194	1.02	5155.
33	7.	50.1	38.5	11.	15.	.....	.....	.....	.149	.787	6711.
34	6.3	39.74	31.2	10.3	14.3	.....	.....	.....	.120	.634	8333.
35	5.6	31.5	24.7	9.6	13.6	.....	.....	.....	.0952	.503	10504.
36	5.	25.	19.6	8.5	12.	.....	.....	.....	.0758	.400	13193.

This table applies to annealed high conductivity wire. Calculations are correct within one-half of 1 per cent. *Permissible Variations.*—Bare diameter 1 per cent. high or low down to and including 10 mils; below 10 mils, 0.1 of a mil high or low. Cross section, 2 per cent. high or low down to and including 10 mils dia.; covered dia. is maximum permissible. Weight, 2 per cent. high or low down to and including 10 mils dia. Resistance, 4 per

Contributed by O. Stegeman, MACHINERY'S Data Sheet No. 39. Explanatory note: Page 3.

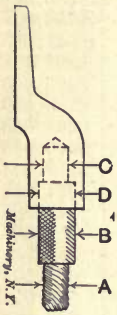
ROUND COPPER WIRE (Continued).

	OHMS.							
	25° CENTIGRADE.				65° CENTIGRADE.			
	Per 1000 feet.	Per pound.	Pounds per Ohm.	Feet per Ohm.	Per 1000 feet.	Per pound.	Pounds per Ohm.	Feet per Ohm.
0000	.0503	.0000785	12744.05	19880.72	.0584	.0000911	10976.28	17123.29
000	.0633	.0001244	8039.588	15797.79	.0735	.0001444	6923.919	13605.44
00	.0800	.0001985	5038.251	12500.00	.0928	.0002303	4347.699	10786.64
0	.101	.0003156	3168.317	9900.990	.117	.0003656	2735.043	8547.008
1	.127	.0005020	1989.379	7874.016	.147	.0005810	1720.901	6802.721
2	.160	.0007921	1262.371	6250.000	.185	.0009158	1091.780	5405.405
3	.204	.0012830	779.4498	4901.961	.235	.0014779	676.6289	4255.319
4	.256	.0020317	492.1570	3906 250	.297	.0023571	424.2161	3367.003
5	.321	.0032100	311.5265	3115.265	.373	.0037300	268.0965	2680.965
6	.406	.0051069	195.7853	2463.054	.472	.0059371	168.4296	2118.644
7	.514	.0081847	122.2063	1945.525	.596	.0094904	105.3093	1677.852
8	.640	.0126984	74.21870	1562.500	.743	.0147421	67.83745	1345.895
9	.819	.0207867	48.10875	1221.001	.951	.0241371	41.43085	1051.525
10	1.02	.0323809	30.87849	980.3922	1.19	.0377777	26 46728	840.3361
11	1.29	.0513944	19.45753	775.1930	1.49	.0593625	16 84591	671.1409
12	1.62	.0814070	12.28267	617.2840	1.88	.0944723	10.58537	531.9149
13	2.05	.1305732	7.657834	487.8049	2.38	.1515924	6.596047	420.1682
14	2.60	.2096766	4.768940	384.6154	3.01	.2427419	4.119354	332.2259
15	3.28	.3329949	3.003425	304.8476	3.80	.3859898	2.592689	263.1579
16	4.09	.5190355	1.926698	244.4988	4.74	.6015228	1.662494	210.9705
17	5.26	.8566775	1.167060	190.1141	6.10	.9934853	1.006350	163.9344
18	6.65	1.371134	.7293453	150.3910	7.72	1.591753	.6281495	129.5337
19	8.21	2.089059	.4785933	121.8027	9.52	2.422392	.4127387	105.0420
20	10.4	3.354839	.2980564	96.15385	12.1	3.903226	.2561829	82.64463
21	13.1	5.325203	.1641279	76.33588	15.2	6.178862	.1414523	65.78947
22	16.3	8.274112	.1208623	61.34969	18.9	9.593909	.1042357	52.91005
23	20.1	12.56250	.0796020	49.75124	23.3	14.56250	.0686694	42.91845
24	26.6	21.98347	.0454958	37.59774	30.9	25.53719	.0391608	32.36246
25	32.9	33.50306	.0298577	30.39514	38.1	38.79837	.0257826	26.24672
26	41.6	53.60825	.0149142	24.03846	48.3	62.25515	.0160620	20.70393
27	54.3	91.41414	.0109349	18.41436	63.0	106.0606	.0094258	15.87302
28	67.0	139.2931	.0071791	14.92537	77.7	161.5385	.0061973	12.88417
29	88.0	239.7820	.0041701	11.36364	102.	277.9292	.0035978	9.803922
30	106.	349.8350	.0028588	9.433962	123.	405.9406	.0024639	8.130813
31	131.	534.6939	.0018701	7.633588	152.	620.4082	.0016117	6.578947
32	166.	855.6701	.0011686	6.024096	193.	994.8454	.0010051	5.181347
33	217.	1456.375	.0006890	4.608295	253.	1697.987	.0005889	3.952569
34	268.	2233.333	.0004478	3.731343	311.	2591.666	.0003859	3.215434
35	339.	3560.924	.0002808	2.949841	399.	4191.177	.0002383	2.506266
36	426.	5620.053	.0001779	2.347418	494.	6517.150	.0001534	2.024292

cent. high, average variation 2.5 per cent. to 3 per cent. low. *Weight.*—One cubic inch of copper = 0.3215 pounds; specific gravity = 8.9. *Resistance.*—Per inch / inch^2 = 0.697 microhms at 25° c ,and 0.808 microhms at 65° c. *Temperature Coefficient.*—0.4 per cent. per °c. measured from 25° c. Resistance at T° c. (above 25° c.) = R (at 25° c.) [+ 0.004 (T−25)]. Resistance at T° c. (below 25° c.) = R (at 25° c) [1 − 0.004 (25 − T)].

Contributed by O. Stegeman, MACHINERY'S Data Sheet No. 39. Explanatory note: Page 3.

RUBBER COVERED CABLES.



This table is for the flexible rubber covered cables as are generally used by all electric generator and motor manufacturers and by power station operators for making connections between generators or motors and the switch board. They must not be confused with "power cables." Drills "C" and "D" allow for solder. Carrying capacity is in amperes.

No. of Cable, B. & S. Gage.	Area in Circular Mills.	Diameter		Drills in Terminal.		Max. Carrying Capacity.			
						Fire Underwriters' Schedule.		Rubber Covered, Entire Surface Exposed to the Air.	
		Bare (A)	Outside (B)	C	D	Rubber Insulation.	Other Insulation.	10° c. Rise.	30° c. Rise.
.....	600000	1.033	1.362	$1\frac{3}{32}$	$1\frac{7}{16}$	450	680	500	855
.....	550000	.995	1.324	$1\frac{1}{16}$	$1\frac{13}{32}$	420	635	480	791
.....	500000	.956	1.254	$1\frac{1}{32}$	$1\frac{11}{32}$	390	590	460	771
.....	450000	.911	1.209	1	$1\frac{9}{32}$	360	545	430	735
.....	400000	.840	1.138	$\frac{29}{32}$	$1\frac{7}{32}$	330	500	400	680
.....	350000	.810	1.108	$\frac{7}{8}$	$1\frac{3}{16}$	300	450	370	650
.....	300000	.750	1.048	$\frac{13}{16}$	$1\frac{1}{8}$	270	400	330	565
.....	250000	.715	1.013	$\frac{25}{32}$	$1\frac{3}{32}$	235	350	285	485
0000	211600	.600	.898	$\frac{11}{16}$	$\frac{31}{32}$	210	312	245	440
000	168100	.540	.838	$\frac{5}{8}$	$\frac{29}{32}$	177	262	215	390
00	133225	.510	.808	$\frac{19}{32}$	$\frac{7}{8}$	150	220	185	330
0	105625	.459	.664	$\frac{17}{32}$	$\frac{3}{4}$	127	185	160	285
1	83521	.360	.565	$\frac{7}{16}$	$\frac{21}{32}$	107	156	140	245
2	66564	.324	.529	$\frac{13}{32}$	$\frac{19}{32}$	90	131	125	220
3	52441	.288	.493	$\frac{3}{8}$	$\frac{9}{16}$	76	110	105	190
4	41616	.257	.442	$\frac{11}{32}$	$\frac{17}{32}$	65	92	85	155
5	33124	.228	.413	$\frac{5}{16}$	$\frac{1}{2}$	54	77	75	135
6	26244	.203	.388	$\frac{9}{32}$	$\frac{15}{32}$	46	65	65	115
8	16384	.161	.315	$\frac{1}{4}$	$\frac{3}{8}$	33	46	50	85
10	10404	.148	.300	$\frac{7}{32}$	$\frac{3}{8}$	24	32	40	70
12	6561	.121	.263	$\frac{3}{16}$	$\frac{11}{32}$	17	23	30	50
14	4096	.076	.219	$\frac{5}{32}$	$\frac{9}{32}$	12	16	20	40
16	2601	.060	.184	$\frac{1}{8}$	$\frac{1}{4}$	6	8	15	30
18	1600	.048	.172	$\frac{1}{8}$	$\frac{1}{4}$	3	5	12	25

CURRENT DENSITIES FOR VARIOUS KINDS OF CONTACTS AND FOR CROSS SECTION OF DIFFERENT MATERIALS.

KIND OF CONTACT.	MATERIAL.	CURRENT DENSITY.	
		Amperes per Square Inch.	Square Mils per Ampere.
SLIDING CONTACT (Brushes)	Copper Brush	150 to 175	5700 to 6700
	Brass Gauze Brush	100 to 125	8000 to 10000
	Carbon Brush	30 to 40	25000 to 33300
SPRING CONTACT (Switch Blades)	Copper on Copper	60 to 80	12500 to 16700
	Composition on Copper	50 to 60	16700 to 20000
	Brass on Brass	40 to 50	20000 to 25000
SCREWED CONTACT	Copper to Copper	150 to 200	5000 to 6700
	Composition to Copper	125 to 150	6700 to 8000
	Composition to Composition	100 to 125	8000 to 10000
CLAMPED CONTACT	Copper to Copper	100 to 125	8000 to 10000
	Composition to Copper	75 to 100	10000 to 13000
	Composition to Composition	70 to 90	11000 to 14000
FITTED CONTACT (Taper Plugs)	Copper to Copper	125 to 175	5700 to 8000
	Composition to Copper	100 to 125	8000 to 10000
	Composition to Composition	75 to 100	10000 to 13000
FITTED AND SCREWED CONTACT	Copper to Copper	200 to 250	4000 to 5000
	Composition to Copper	175 to 200	5000 to 5700
	Composition to Composition	150 to 175	5700 to 6700
CROSS SECTION	Copper Wire	1200 to 2000	500 to 800
	Copper Wire Cable	1000 to 1600	600 to 1000
	Copper Rod	800 to 1200	800 to 1200
	Composition Casting	500 to 700	1400 to 2000
	Brass Casting	300 to 400	2500 to 3300
	Brass Rod	575 to 750	1300 to 1700

Contributed by O. Stegeman, MACHINERY'S Data Sheet No. 39. Explanatory note: Page 3.

SPEED, HORSEPOWER, AND CAPACITY OF CENTRIFUGAL FANS—I

Height of Casing in Inches	Diameter of Fan in Feet	Speed, horse-power, and capacity in cubic feet per minute for centrifugal fans discharging into free air. *							
			1/4 oz.	3/8 oz.	1/2 oz.	5/8 oz.	3/4 oz.	7/8 oz.	1 oz.
40	2	R. P. M.	493	605	698	780	854	923	980
		H. P.	0.4	0.8	1.2	1.7	2.5	2.9	3.5
		Cu. Ft.	2585	3165	3653	4084	4472	4829	5161
50	2 1/2	R. P. M.	395	484	558	624	684	738	788
		H. P.	0.7	1.2	1.9	2.6	3.8	4.3	5.2
		Cu. Ft.	3877	4747	5480	6126	6708	7244	7741
60	3	R. P. M.	328	403	465	531	570	615	657
		H. P.	1.0	1.9	2.8	3.8	5.0	6.4	7.9
		Cu. Ft.	5690	6960	7380	8980	9840	10600	11350
70	3 1/2	R. P. M.	282	345	398	446	488	526	562
		H. P.	1.5	2.5	3.8	5.4	7.0	8.8	10.8
		Cu. Ft.	7750	9490	10950	12250	13400	14500	15500
80	4	R. P. M.	247	302	349	390	427	460	493
		H. P.	1.8	3.3	5.0	6.9	9.1	11.5	14.0
		Cu. Ft.	10350	12650	14600	16350	17900	19300	20650
90	4 1/2	R. P. M.	219	268	309	346	379	410	438
		H. P.	2.3	4.0	6.3	8.8	11.5	14.5	17.8
		Cu. Ft.	12950	15850	18250	20400	22350	24150	25800

* For schools, churches, etc., reduce capacity and horse-power 20 per cent for given speed. For shops and factories reduce capacity and horse-power 40 per cent for given speed.

Contributed by Chas. L. Hubbard, MACHINERY'S Data Sheet No. 88. Explanatory note: Page 3.

SPEED, HORSEPOWER, AND CAPACITY OF CENTRIFUGAL FANS—II

Height of Casing in Inches	Diameter of Fan in Feet	Speed, horse-power, and capacity in cubic feet per minute for centrifugal fans discharging into free air. *							
			1/4 oz.	3/8 oz.	1/2 oz.	5/8 oz.	3/4 oz.	7/8 oz.	1 oz.
100	5	R.P.M.	196	242	278	312	342	369	394
		H.P.	2.8	5.0	7.8	10.3	14.3	17.9	21.9
		Cu. Ft.	16050	19600	22650	25500	27750	29950	32000
120	6	R.P.M.	164	201	232	260	285	307	328
		H.P.	3.9	7.3	11.1	15.3	20.4	25.8	35.1
		Cu. Ft.	23250	28600	32900	36750	40250	43450	46450
140	7	R.P.M.	140	172	199	223	243	264	282
		H.P.	5.3	10.0	15.3	21.3	27.9	35.1	42.3
		Cu. Ft.	31550	38600	44600	49800	54550	58950	62950
160	8	R.P.M.	123	151	175	195	213	230	246
		H.P.	7.0	13.0	20.0	28.0	36.7	46.4	56.8
		Cu. Ft.	40850	50000	57750	64550	70650	76300	81550
180	9	R.P.M.	110	134	154	172	189	205	219
		H.P.	8.8	16.1	25.0	34.8	45.6	57.5	70.4
		Cu. Ft.	53200	63950	73750	82500	90350	97560	104250
200	10	R.P.M.	98	121	139	156	170	184	197
		H.P.	11.0	20.3	31.1	43.5	57.1	72.0	88.0
		Cu. Ft.	64100	78500	90600	101300	110950	119800	128000

* For schools, churches, etc., reduce capacity and horse-power 20 per cent for given speed.
For shops and factories reduce capacity and horse-power 40 per cent for given speed.

appertain to the measurement of volume, pressure and horsepower of blowers at pressures from 1 to 10 pounds per square inch.

The friction varies as the square of the velocity and inversely as the diameter of the pipe. Therefore, if the diameter of the pipe is doubled, the friction loss is divided by 32, provided of course the same volume is carried. The advisability of using a large pipe for conveying the air is thus clearly shown.

The volume of air discharged from an orifice or pipe is theoretically equal to the product of the velocity of the air flowing and the area of the orifice. Hence for the calculation of the volume, the velocity is an important factor. To determine the velocity, an instrument known as the Pitot tube is commonly used.

In the diagram on page 18 the four diagonal lines drawn correspond, respectively, to the four formulas given at the right-hand side of the diagram. The required horsepower per 100 cubic feet of free air per minute is found by first locating the pressure in pounds per square inch on the scale at the bottom of the diagram, and then following the vertical line from the point so located until it intersects the diagonal line corresponding to the conditions in the particular case in hand. Then from the point of intersection, the horizontal line is followed to the scale at the left-hand side, where the required horsepower is read off. The conditions to which each of the four diagonal lines apply are stated in the explanatory notes at the right-hand side of the diagram.

The diagram on page 19 is used for finding the velocity in feet per minute of air and gas for pressures varying from 0 to 12 pounds per square inch. First locate the given pressure on the vertical scale to the left, and follow the horizontal line from the point so located until it intersects the curve for air or gas, as the case may be. Then from the point of intersection follow a vertical line downward to the bottom scale where the velocity in feet per minute is read off directly. [MACHINERY, April, 1907, Volume, Pressure and Horsepower of Blower Performance.]

Capacities of Hot Water Mains

On pages 20 and 21 three sets of curves are given for determining the sizes of pipe mains for hot water heating. Two of the diagrams are for gravity circulation, where the water is moved under a low head, the motion being due solely to the difference in temperature between the supply and return. The third diagram is made up for the usual range of velocity and head employed in forced hot water circulation actuated by means of a pump. In all cases the capacities are for pipe lengths of 100 feet.

The volume of water to be passed through the supply main in a heating system may be found by the following equation:

$$G = \frac{E \times H}{8.3 \times (T - T_1)}$$

in which G = gallons per hour,

E = efficiency of radiating surface (170 for direct, 400 for indirect, and 1000 for hot blast heating),

H = square feet of heating surface,

T = initial temperature of water (commonly taken as 180 degrees),

T_1 = final temperature of water (commonly taken as 160 degrees).

Example.—A heating system has 5000 square feet of direct heating surface, and 1000 of indirect; how many gallons of water (G_1) must pass through the main per minute, assuming a drop in temperature of 20 degrees?

$$G_1 = \frac{(170 \times 5000) + (400 \times 1000)}{8.3 \times 20 \times 60}$$

$= 125$ gallons.

(Continued on page 16.)

VOLUME, PRESSURE AND HORSEPOWER OF BLOWER PERFORMANCE—I

Weight per Cubic Foot of Dry Air under Different Pressures and Temperatures.
Atmospheric Pressure in Table = 29.92 Inches of Mercury.

Temp. °F.	Vacuum in Inches of Mercury					Pressure above Atmosphere in Pounds per Square Inch																		Temp. °F.
	10	8	6	4	2	0	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0	
−20	.0602	.0662	.0722	.0782	.0844	.0904	.0934	.0965	.0995	.1026	.1056	.1087	.1117	.1148	.1178	.1209	.1239	.1270	.1300	.1331	.1361	.1392	.1453	.1514	−20
−10	.0589	.0648	.0707	.0766	.0825	.0884	.0914	.0944	.0974	.1004	.1034	.1064	.1094	.1124	.1154	.1184	.1213	.1243	.1273	.1303	.1333	.1363	.1423	.1482	−10
0	.0576	.0634	.0691	.0749	.0806	.0864	.0893	.0923	.0952	.0982	.1011	.1041	.1070	.1100	.1130	.1159	.1189	.1218	.1248	.1277	.1306	.1335	.1393	.1451	0
10	.0564	.0620	.0677	.0733	.0789	.0846	.0875	.0903	.0932	.0961	.0989	.1018	.1047	.1075	.1103	.1132	.1160	.1188	.1217	.1246	.1275	.1304	.1362	.1420	10
20	.0552	.0607	.0663	.0718	.0773	.0829	.0857	.0885	.0913	.0941	.0969	.0997	.1025	.1053	.1081	.1109	.1137	.1165	.1193	.1221	.1249	.1277	.1333	.1390	20
30	.0541	.0595	.0649	.0703	.0758	.0812	.0839	.0867	.0894	.0922	.0949	.0977	.1004	.1032	.1059	.1086	.1113	.1140	.1167	.1195	.1223	.1250	.1305	.1362	30
40	.0529	.0582	.0636	.0689	.0742	.0796	.0823	.0850	.0877	.0904	.0931	.0958	.0985	.1012	.1039	.1066	.1093	.1120	.1147	.1174	.1201	.1228	.1282	.1336	40
50	.0518	.0570	.0623	.0675	.0727	.0779	.0806	.0833	.0859	.0886	.0912	.0939	.0966	.0993	.1020	.1047	.1074	.1101	.1128	.1155	.1182	.1209	.1263	.1318	50
60	.0509	.0560	.0611	.0662	.0713	.0765	.0790	.0816	.0842	.0868	.0894	.0920	.0946	.0972	.0997	.1023	.1049	.1075	.1101	.1127	.1153	.1179	.1231	.1283	60
70	.0500	.0550	.0600	.0650	.0700	.0751	.0776	.0802	.0827	.0853	.0878	.0893	.0919	.0944	.0969	.1004	.1029	.1055	.1080	.1106	.1131	.1157	.1208	.1259	70
80	.0491	.0540	.0589	.0638	.0687	.0737	.0761	.0785	.0810	.0835	.0860	.0885	.0910	.0935	.0960	.0985	.1010	.1035	.1060	.1085	.1110	.1135	.1185	.1236	80
90	.0482	.0530	.0578	.0626	.0674	.0723	.0747	.0772	.0796	.0821	.0845	.0870	.0895	.0920	.0944	.0969	.0993	.1017	.1041	.1065	.1089	.1113	.1163	.1212	90
100	.0473	.0521	.0568	.0615	.0662	.0710	.0733	.0757	.0781	.0805	.0829	.0853	.0877	.0901	.0925	.0949	.0973	.0997	.1021	.1045	.1069	.1093	.1141	.1190	100
110	.0465	.0511	.0557	.0604	.0650	.0697	.0720	.0744	.0767	.0791	.0814	.0838	.0861	.0885	.0908	.0932	.0955	.0978	.1001	.1025	.1049	.1073	.1121	.1169	110
120	.0458	.0503	.0548	.0593	.0638	.0684	.0707	.0730	.0753	.0776	.0799	.0822	.0845	.0868	.0891	.0915	.0938	.0962	.0985	.1009	.1034	.1057	.1103	.1149	120
130	.0449	.0493	.0538	.0583	.0628	.0673	.0695	.0718	.0741	.0764	.0787	.0810	.0833	.0856	.0878	.0900	.0923	.0946	.0969	.1992	.1015	.1038	.1084	.1130	130
140	.0441	.0485	.0529	.0573	.0617	.0662	.0684	.0707	.0729	.0752	.0774	.0797	.0819	.0842	.0864	.0886	.0908	.0931	.0953	.0976	.0998	.1021	.1066	.1111	140
150	.0433	.0476	.0519	.0562	.0606	.0650	.0672	.0694	.0716	.0738	.0761	.0783	.0805	.0827	.0849	.0872	.0894	.0916	.0938	.0960	.0982	.1004	.1048	.1092	150
160	.0426	.0468	.0511	.0554	.0597	.0640	.0660	.0680	.0701	.0722	.0743	.0764	.0785	.0806	.0827	.0858	.0880	.0901	.0923	.0944	.0966	.0987	.1030	.1074	160
170	.0419	.0461	.0503	.0545	.0587	.0630	.0651	.0673	.0694	.0716	.0737	.0759	.0780	.0802	.0823	.0844	.0865	.0886	.0907	.0929	.0950	.0972	.1014	.1057	170
180	.0412	.0453	.0494	.0536	.0578	.0620	.0641	.0662	.0683	.0704	.0725	.0746	.0767	.0788	.0809	.0830	0851	.0872	.0893	.0914	.0935	.0956	.0998	.1041	180
190	.0406	.0446	.0487	.0528	.0569	.0610	.0630	.0650	.0670	.0691	.0712	.0733	.0754	.0775	.0796	.0817	.0837	.0857	.0878	.0899	.0920	.0941	.0983	.1025	190
200	.0400	.0440	.0480	.0520	.0560	.0601	.0621	.0642	.0662	.0683	.0703	.0724	.0744	.0765	.0785	.0805	.0825	.0846	.0866	.0887	.0907	.0928	.0969	.1010	200
250	.0370	.0407	.0445	.0483	.0511	.0559	.0578	.0597	.0616	.0635	.0654	0673	.0692	.0711	.0720	.0749	.0767	.0786	.0805	.0824	.0843	.0862	.0900	.0938	250
300	.0344	.0379	.0414	.0450	.0486	.0522	.0539	.0556	.0574	.0592	.0610	.0628	.0646	.0664	.0682	.0700	.0717	.0734	.0752	.0770	.0788	.0806	.0842	.0878	300
350	.0325	.0358	.0391	.0424	.0457	.0490	.0506	.0522	.0538	.0555	.0572	.0589	.0606	.0623	.0640	.0657	.0674	.0690	.0707	.0723	.0740	.0756	.0789	.0823	350
400	.0308	.0338	.0368	.0399	.0430	.0461	.0476	.0491	.0506	.0522	.0538	.0554	.0570	.0596	.0612	.0618	.0634	.0649	.0665	.0680	.0696	.0711	.0743	.0774	400
450	.0291	.0320	.0349	.0378	.0407	.0436	.0450	.0465	.0479	.0494	.0508	.0523	.0537	.0552	.0566	.0580	.0595	.0610	.0626	.0641	.0656	.0671	.0701	.0732	450
500	.0275	.0302	.0329	.0357	.0385	.0413	.0427	.0441	.0455	.0469	.0483	.0497	.0511	.0525	.0539	.0553	.0567	.0581	.0595	.0609	.0623	.0637	.0665	.0694	500
550	.0262	.0288	.0314	.0340	.0366	.0393	.0406	.0419	.0432	.0445	.0458	.0471	.0485	.0499	.0513	.0526	.0539	.0554	.0567	.0581	.0594	.0607	.0633	.0660	550
600	.0250	.0274	.0299	.0324	.0349	.0374	.0386	.0398	.0410	.0423	.0436	.0449	.0462	.0475	.0488	.0501	.0513	.0525	.0538	.0551	.0564	.0577	.0603	.0629	600

The head to produce flow may be found by the equation

$$H = D \times h \times 0.000365$$

in which

H = head in feet, producing flow,

D = difference in temperature between supply and return,

h = height or elevation of the heating surface above the boiler.

Example.—A certain quantity of heating surface is located at an elevation of 50 feet above the boiler; what is the available head for producing flow through the supply riser if the drop in temperature between the supply and return is 30 degrees?

$$H = 30 \times 50 \times 0.000365 = 0.55 \text{ foot.}$$

When the radiation is all on the same floor, the elevation h may be taken as the vertical distance between the center of the radiators and the center of the boiler. If it is equally distributed on several floors it may be taken as though it were all located upon the central floor.

If unevenly distributed, the *average elevation* may be found by the equation

$$h = \frac{A \times h_a + B \times h_b + C \times h_c}{A + B + C}$$

in which A, B, and C are the square feet of radiation upon the several floors, and h_a, h_b, and h_c the corresponding elevations of the radiators located upon these floors.

In computing the length of mains, provision must be made for the frictional resistance due to bends in the pipe. In practice it is customary to consider an elbow equivalent to increasing the length of the pipe 60 diameters, and a return bend equivalent to 120 diameters.

The size of main required to supply a heating system or group of heaters depends upon the square feet of radiation, the elevation above the boiler, the drop in temperature of the water in passing through the radiators, and the length of run. Taking the examples previously given, and assuming the length of the mains to be 200 feet, what size of pipe will be required?

Gallons per minute 125; available head to produce flow 0.55 foot. As the run of pipe is 200 feet long, the head per hundred feet is $\frac{0.55}{2} = 0.27$ foot. From the diagram to the left on page 21, we find that a flow of 125 gallons under a head of 0.27 foot calls for a pipe between 5 and 6 inches in diameter, in which case the larger size would probably be used.

In case of forced circulation the mains should be of such size that the total head required to overcome the friction will not exceed 50 feet, the usual range being from 30 to 50 feet. The velocity of flow is usually made from 5 feet per second in the smaller sizes (2 to 3 inches) to 10 feet per second in the larger sizes (6 to 8 inches).

Brakes

On page 22 a diagram is presented for the designing of band brakes. Directions for using the diagram are given on page 23 together with formulas and tables for use in band brake design.

On page 24 another set of formulas for band brakes is given and on page 25 a set of formulas for block brakes. Formulas for band and block brakes are not easily obtained, because many mechanical hand-books do not give any information on this subject. In order to supply a possible need in this direction, the formulas given have been compiled. These formulas are based on, and agree in form with, the formulas for these classes of brakes given in "Des Ingenieurs Taschenbuch," published by the Hütte Association, Berlin, Germany.

In any band brake, such as shown in Fig. 1, page 24, where the brake wheel rotates in a clockwise direction,

(Continued on page 28.)

VOLUME, PRESSURE AND HORSEPOWER OF BLOWER PERFORMANCE—II

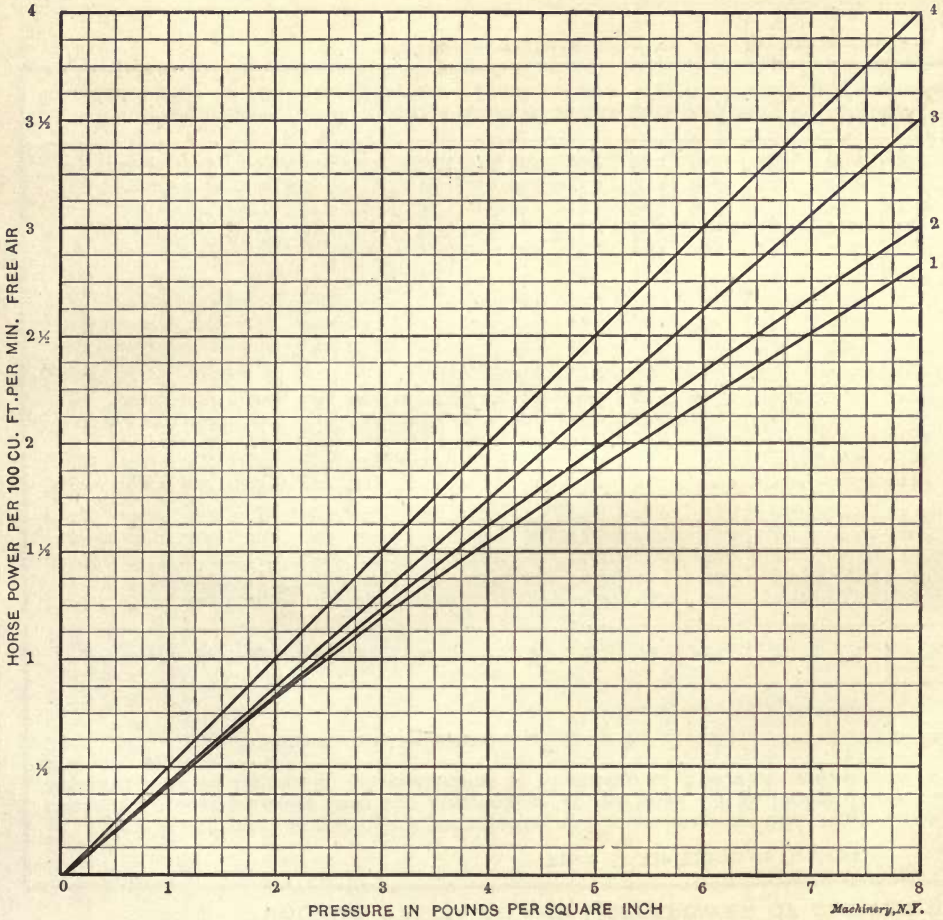
Flow of Air Through Orifices.

Flow is expressed in cubic feet per minute, and is assumed to take place from a receiver or other vessel in which air is contained under pressure into the atmosphere at sea level (29.92 inches barometer). Temperature of air in receiver is assumed to be 50 degrees F. A coefficient of discharge of 0.60 was used, which is approximately correct for orifices with narrow edges.

Gauge Pres. in Receiver. Lbs. per Sq. In.	Diameter of Orifice in Inches																				
	1/64	1/32	3/64	1/16	3/32	1/8	3/16	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4	2	2 1/2
1/2	.0118	.0478	.106	.190	.428	.763	1.73	3.45	6.86	12.2	19.0	27.4	37.4	48.8	62.0	76.3	92.2	110	150	195	345
1	.0170	.0686	.154	.274	.615	1.10	2.48	4.37	9.84	17.5	28.6	39.4	53.6	70.	89.1	110	132	157	214	280	437
1 1/2	.0211	.0855	.192	.340	.775	1.36	3.09	5.44	1.23	21.7	34.0	49.0	66.6	87.	111	135	164	196	266	348	545
2	.0247	.100	.225	.399	.896	1.60	3.61	6.37	14.4	25.5	39.8	57.5	78.1	103	130	160	193	233	312	409	638
2 1/2	.0280	.114	.255	.453	1.02	1.81	4.06	7.23	16.3	29.0	45.3	65.1	88.7	116	147	181	218	260	355	463	723
3	.0311	.126	.283	.501	1.13	2.01	4.54	8.03	18.1	32.1	50.1	72.3	98.1	128	163	201	243	289	393	514	803
3 1/2	.0341	.138	.310	.550	1.23	2.20	5.00	8.80	19.8	35.2	55.1	79.3	108	141	179	220	266	317	431	564	880
4	.0370	.150	.336	.596	1.34	2.38	5.40	9.55	21.4	38.3	59.6	86.0	118	153	194	239	289	344	469	612	960
4 1/2	.0397	.161	.360	.642	1.44	2.56	5.81	10.3	23.0	41.0	64.0	92.4	126	164	209	256	310	369	503	656	1030
5	.0423	.171	.386	.685	1.54	2.74	6.20	10.9	24.6	43.8	68.4	98.5	134	176	223	274	330	394	536	700	1100
5 1/2	.0450	.184	.410	.727	1.63	2.90	6.58	11.6	26.1	46.5	72.6	105	143	186	236	290	351	418	570	744	1160
6	.0478	.194	.435	.770	1.74	3.08	6.99	12.4	27.7	49.4	77.1	111	151	198	251	308	374	444	605	790	1230
6 1/2	.0501	202	.455	.808	1.82	3.23	7.31	12.9	29.1	51.7	80.7	116	158	207	264	322	390	464	634	827	1290
7	.0538	.213	.479	.849	1.91	3.40	7.70	13.6	30.6	54.4	84.9	121	166	217	276	340	411	490	666	870	1360
7 1/2	.0552	.224	.503	.890	2.00	3.56	8.07	14.2	32.1	57.0	89.0	128	175	227	290	356	431	512	698	911	1420
8	.0574	.233	.523	.925	2.08	3.70	8.39	14.9	33.3	59.3	92.5	134	182	238	302	372	448	535	726	949	1490
8 1/2	.0601	.244	.546	.970	2.17	3.86	8.78	15.5	34.9	62.1	96.8	139	190	248	316	389	468	558	761	994	1560
9	.0634	.255	.570	1.01	2.26	4.02	9.15	16.1	35.4	65.1	101	146	197	260	331	407	489	585	795	1040	1630
9 1/2	.0659	.265	.590	1.05	2.35	4.16	9.48	16.6	37.8	67.1	105	152	205	271	344	424	507	607	826	1080	1700
10	.0686	.274	.609	1.09	2.42	4.28	9.78	17.1	39.0	69.4	109	157	212	281	358	439	526	628	859	1120	1760

For other orifices, the flow varies directly as the area, and may be computed from the table by multiplying the area in square inches by the value given for a 1 1/8-inch orifice, which has an area of one square inch.

VOLUME, PRESSURE AND HORSEPOWER OF BLOWER PERFORMANCE—III



$$\text{H. P.} = \frac{V P l_e \left(\frac{P_1}{P}\right)}{33{,}000} \qquad (1)$$

$$\text{H. P.} = \frac{V P \left[\left(\frac{P_1}{P}\right)^{\frac{1}{3}} - 1\right]}{11{,}000} \qquad (2)$$

$$\text{H. P.} = \frac{V (P_1 - P)}{33{,}000} \qquad (3)$$

$$\text{H. P.} = \frac{\text{lbs. per sq. in.} \times V}{200} \qquad (4)$$

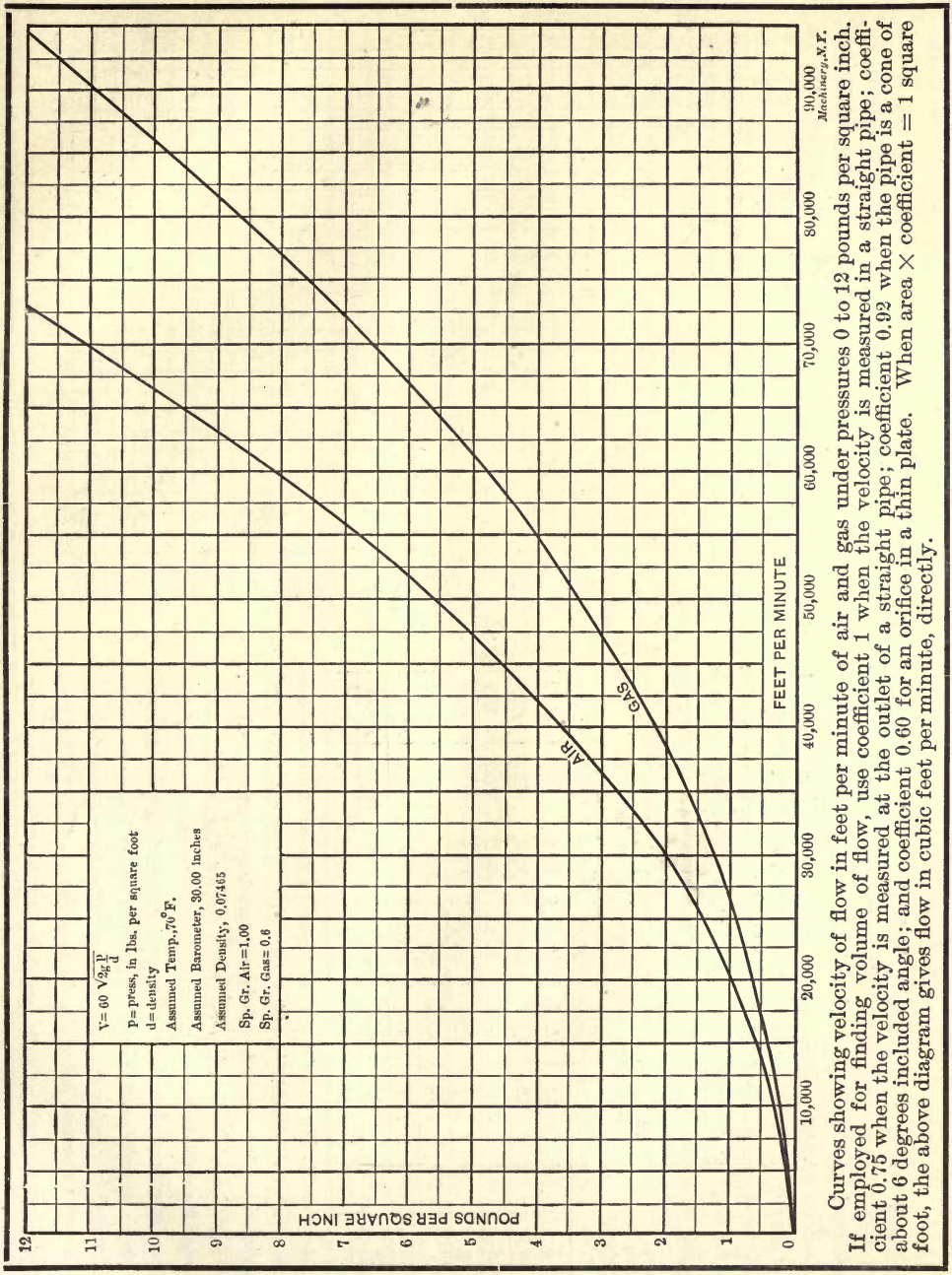
Formula No. 1 gives the horsepower required when air is cooled during compression, as in the ordinary air compressor.

Formula No. 2 is used when it may be assumed that the air is compressed so quickly that it does not have time to cool to atmospheric temperature. Applies to nearly all blower performance.

Formula No. 3 is the ordinary "hydraulic" formula and is ordinarily used for pressures up to 5 ounces per square foot.

Formula No. 4 is used by some makers of positive or rotary blowers. V = volume of air displaced by the impellers, no allowance being made for slippage.

VOLUME, PRESSURE AND HORSEPOWER OF BLOWER PERFORMANCE—IV



Curves showing velocity of flow in feet per minute of air and gas under pressures 0 to 12 pounds per square inch. If employed for finding volume of flow, use coefficient 1 when the velocity is measured in a straight pipe; coefficient 0.75 when the velocity is measured at the outlet of a straight pipe; coefficient 0.92 when the pipe is a cone of about 6 degrees included angle; and coefficient 0.60 for an orifice in a thin plate. When area × coefficient = 1 square foot, the above diagram gives flow in cubic feet per minute, directly.

MACHINERY'S Data Sheet No. 68. Explanatory note: Page 3.

Capacities of Hot Water Mains.

The curves in diagrams I, II, and III give the size of mains for hot water gravity circulation and forced circulation when the gallons of water per minute and the head in feet are known. To find the gallons per minute use equation: $G_1 = \frac{E \times H}{8.3 \times (T - T_1) \times 60}$ in which G_1 = gallons per minute, E = efficiency of radiating surface (170 for direct, 400 for indirect, and 1000 for hot blast heating), H = square feet of heating surface, T = initial temperature of water (commonly 180 degrees F.), T_1 = final temperature of water (commonly 160 degrees F.). The head to produce flow is found from the equation: H = D x h x 0.000365 in which H = head, in feet producing flow, D = difference in temperature between supply and return, h = height or elevation of the heating surface above the boiler.

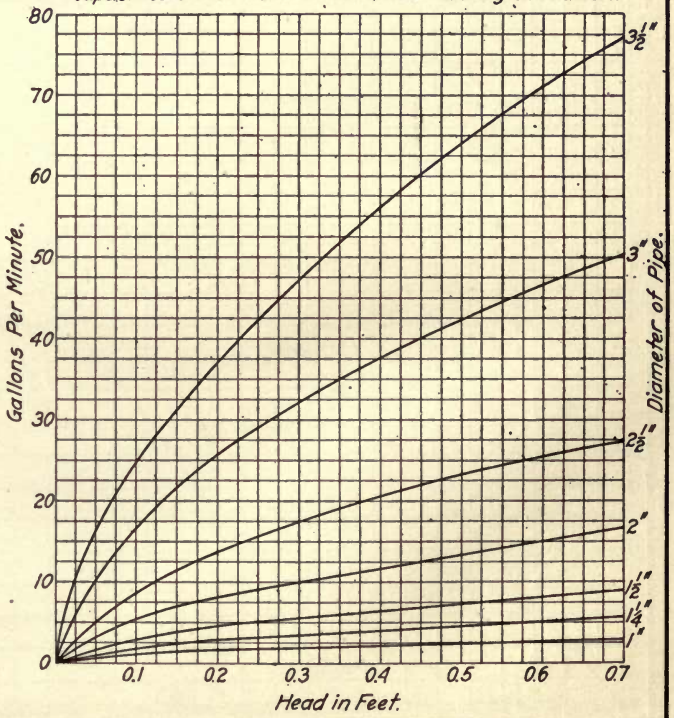
When the radiation is all on the same floor h equals vertical distance between center of radiators and center of boiler. If radiation is equally distributed on several floors it may be taken as though located on the central floor. If unequally distributed, the average elevation is found by the equation: $h = \frac{A \times h_A + B \times h_B + C \times h_C}{A + B + C}$ in which A, B, and C equal square feet of radiation on the several floors, h_A, h_B, and h_C equal corresponding elevations of radiators on the several floors.

In all cases the capacities are for pipe lengths of 100 feet. If the run of pipe is 200 feet, for instance, the available head for this length will be divided by 2 before the size of pipe can be found from the diagrams.

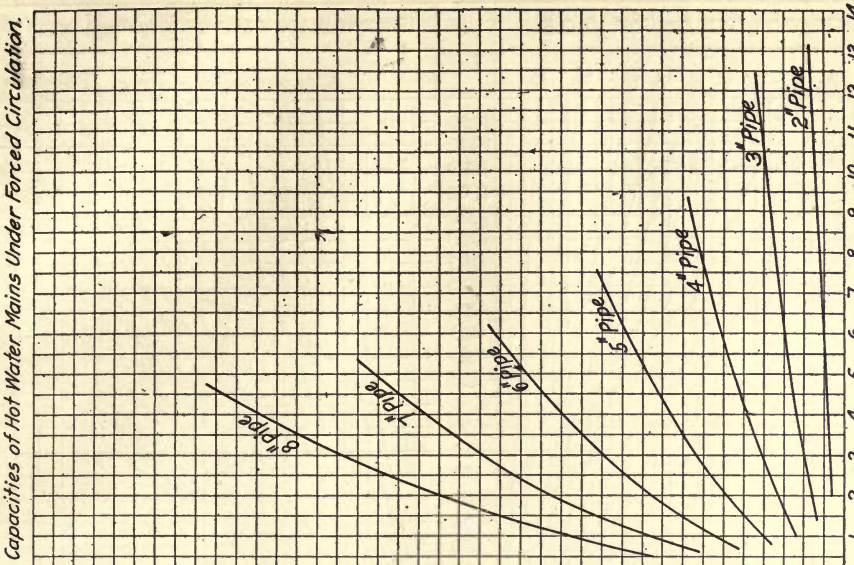
Capacities of Pipes at Different Velocities of Flow.

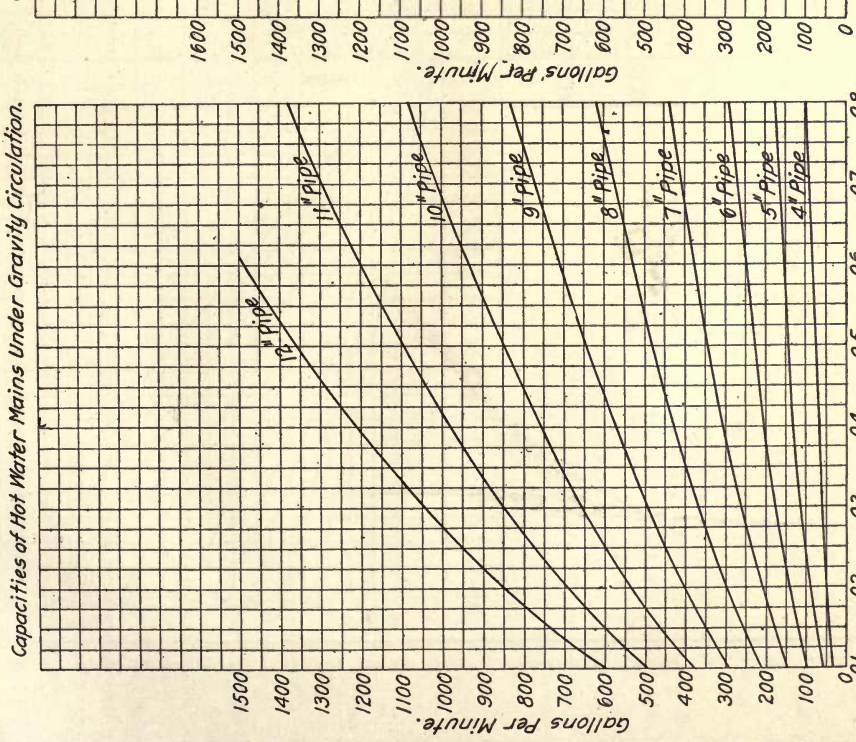
Velocity, feet per second	Gallons discharged per minute						
	2" pipe	3" pipe	4" pipe	5" pipe	6" pipe	7" pipe	8" pipe
3	29	66	117	184	264	360	470
4	39	88	157	245	352	480	627
5	49	110	196	306	440	600	783
6	59	132	236	367	528	719	940
7	68	154	275	428	616	839	1097
8	78	176	314	490	706	959	1253
9	88	198	352	551	794	1079	1410
10	98	220	391	612	882	1199	1567

Capacities of Hot Water Mains Under Gravity Circulation.



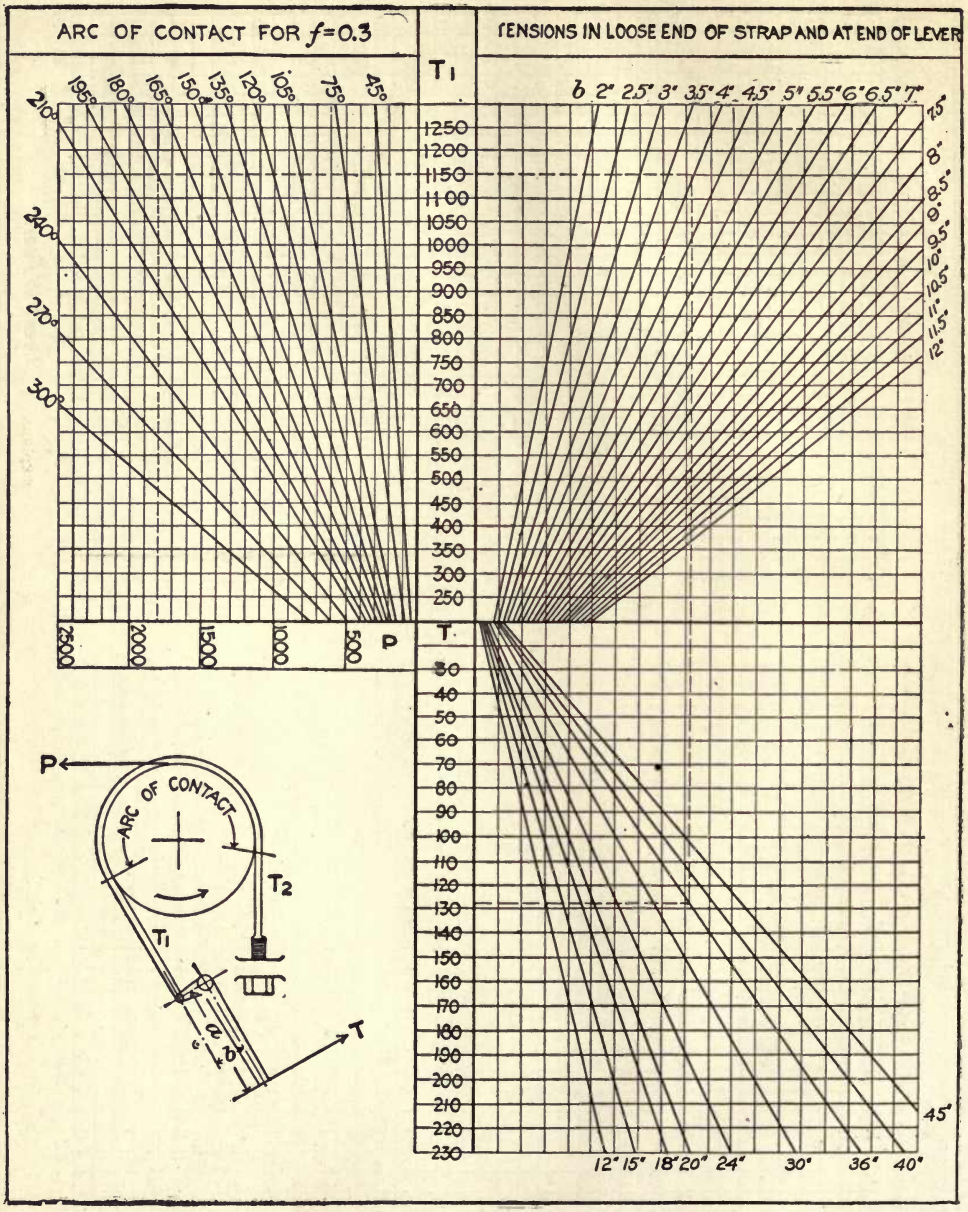
CAPACITIES OF HOT WATER MAINS—II





Contributed by Chas. L. Hubbard, MACHINERY'S Data Sheet No. 115. Explanatory note: Page 14.

DIAGRAM FOR DESIGNING BAND BRAKES—I



Contributed by C. F. Blake, MACHINERY'S Data Sheet No. 18. Explanatory note: Page 16.

DIRECTIONS FOR USING DIAGRAM FOR DESIGNING BAND BRAKES.

Using that part of the chart in the upper left-hand corner, for a coefficient of friction of .3, start with the known load, P, and follow up to the line representing the arc of contact; thence to the right to the line representing the length of arm b; thence down to the line representing the length of arm a; thence to the left and read the pull in pounds required to hold the load P.

Conversely.—Starting with known pull, T, and assumed lever arms a and b, follow back through the chart to part for coefficient of friction and line representing the arc of contact, and below read load, P, which will be held. Knowing load P and arc of contact, and assuming arm b and pull T, arm a will be found at the intersection of the vertical line from arm b and horizontal line from pull T. For T_2 read T_1 in chart and multiply by k as found in table below.

For coefficients of friction other than 0.3 the quantities can be calculated by the formulas given below.

FORMULAS.

$$k = \frac{T_2}{T_1} \qquad P = \frac{Ta\,(k-1)}{b} \qquad T = \frac{Pb}{a\,(k-1)}$$

$$T_1 = \frac{Ta}{b} \qquad T_2 = \frac{kTa}{b} \qquad T_2 = k\,T_1$$

P = Load in pounds on circumference of brake wheel.
T = Pull exerted at lever handle.
T_1 = Tension in loose end of strap.
T_2 = Tension in fixed end of strap.
a = Long lever arm.
b = Short lever arm.

f FOR DIFFERENT MATERIALS ON CAST IRON.

Material.	Wet.	Dry.	Oily.	Greasy.		Authority.
Leather.....	.36	.56	.15	.23	....	Rankine.
"	....	....	....	....	.28	Thurston.
"	....	....	....	....	.18	Hermann.
Oak.....	.20	....	....	....	....	Rankine.

Arc of Contact.	$k = \frac{T_2}{T_1}$ for f			
	f = 0.2	f = 0.3	f = 0.4	f = 0.5
20	1.07	1.11	1.15	1.19
30	1.11	1.17	1.23	1.30
40	1.15	1.23	1.32	1.41
45	1.17	1.26	1.36	1.48
60	1.23	1.36	1.52	1.69
75	1.29	1.48	1.68	1.92
80	1.32	1.52	1.74	2.01
90	1.36	1.60	1.87	2.19
100	1.41	1.68	2.01	2.39
105	1.44	1.73	2.08	2.50
120	1.52	1.87	2.31	2.85
135	1.60	2.02	2.56	3.24
140	1.63	2.08	2.65	3.39
150	1.68	2.19	2.85	3.70
160	1.74	2.31	3.05	4.04
165	1.77	2.37	3.16	4.22
180	1.87	2.56	3.51	4.80
195	1.97	2.77	3.90	5.48
200	2.01	2.85	4.04	5.72
210	2.08	3.00	4.33	6.25
220	2.15	3.16	4.64	6.82
240	2.31	3.51	5.34	8.12
270	2.56	4.11	6.59	10.55
300	2.84	4.80	8.11	13.70

FORMULAS FOR SIMPLE AND DIFFERENTIAL BAND BRAKES

F = force in pounds at end of brake handle,

P = tangential force in pounds at rim of brake wheel,

e = base of natural logarithms = 2.71828,

μ = coefficient of friction between the brake band and the brake wheel,

θ = angle of contact of the brake band with the brake wheel, expressed in radians (one radian = $\frac{180^\circ}{\pi}$ = 57.296 degrees),

$T_1 = P\frac{1}{e^{\mu\theta}-1}$, $T_2 = P\frac{e^{\mu\theta}}{e^{\mu\theta}-1}$

(1) Simple band brake (Fig. 1)

For clockwise rotation:

$$F = \frac{bT_2}{a} = \frac{Pb}{a}\left(\frac{e^{\mu\theta}}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{bT_1}{a} = \frac{Pb}{a}\left(\frac{1}{e^{\mu\theta}-1}\right)$$

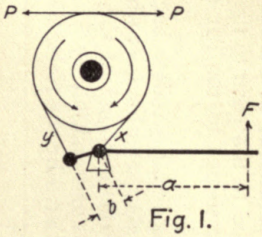


Fig. 1.

(2) Simple band brake (Fig. 2)

For clockwise rotation:

$$F = \frac{bT_1}{a} = \frac{Pb}{a}\left(\frac{1}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{bT_2}{a} = \frac{Pb}{a}\left(\frac{e^{\mu\theta}}{e^{\mu\theta}-1}\right)$$

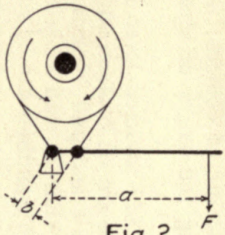


Fig. 2.

(3) Differential band brake (Fig. 3)

For clockwise rotation:

$$F = \frac{b_2T_2 - b_1T_1}{a} = \frac{P}{a}\left(\frac{b_2e^{\mu\theta} - b_1}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{b_2T_1 - b_1T_2}{a} = \frac{P}{a}\left(\frac{b_2 - b_1e^{\mu\theta}}{e^{\mu\theta}-1}\right)$$

In this case, if b_2 is equal to, or less than, $b_1e^{\mu\theta}$, the force F will be 0 or negative and the band brake works automatically.

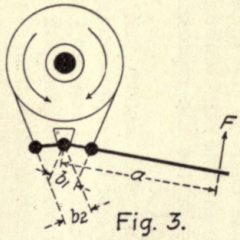


Fig. 3.

(4) Differential band brake (Fig. 4)

For clockwise rotation:

$$F = \frac{b_2T_2 + b_1T_1}{a} = \frac{P}{a}\left(\frac{b_2e^{\mu\theta} + b_1}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{b_1T_2 + b_2T_1}{a} = \frac{P}{a}\left(\frac{b_1e^{\mu\theta} + b_2}{e^{\mu\theta}-1}\right)$$

If $b_2 = b_1$, both of the above formulas reduce to $F = \frac{Pb_1}{a}\left(\frac{e^{\mu\theta}+1}{e^{\mu\theta}-1}\right)$. In this case the same force F is required for rotation in either direction.

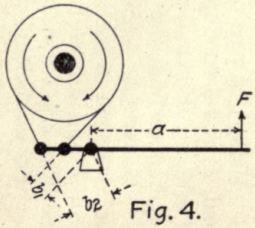


Fig. 4.

FORMULAS FOR BLOCK BRAKES

F = force in pounds at end of brake handle,

P = tangential force in pounds at rim of brake wheel,

μ = coefficient of friction between the brake block and brake wheel.

(1) Block brake (Fig. 1)

For rotation in either direction:

$$F = P\frac{b}{a+b} \times \frac{1}{\mu} = \frac{Pb}{a+b}\left(\frac{1}{\mu}\right)$$

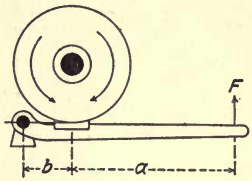


Fig. 1.

(2) Block brake (Fig. 2)

For clockwise rotation:

$$F = \frac{\frac{Pb}{\mu} - Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu} - \frac{c}{b}\right)$$

For counter clockwise rotation:

$$F = \frac{\frac{Pb}{\mu} + Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu} + \frac{c}{b}\right)$$

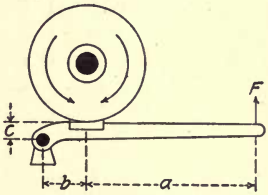


Fig. 2.

(3) Block brake (Fig. 3)

For clockwise rotation:

$$F = \frac{\frac{Pb}{\mu} + Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu} + \frac{c}{b}\right)$$

For counter clockwise rotation:

$$F = \frac{\frac{Pb}{\mu} - Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu} - \frac{c}{b}\right)$$

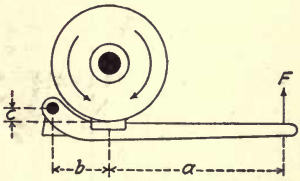


Fig. 3.

The brake wheel and friction block of the block brake are often grooved as shown by Fig. 4. In this case substitute for μ in the above equations the value $\frac{\mu}{\sin\alpha + \mu\cos\alpha}$ where α is one half the angle included by the faces of the grooves.

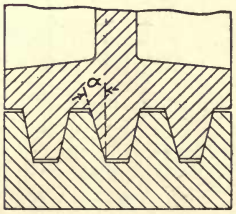
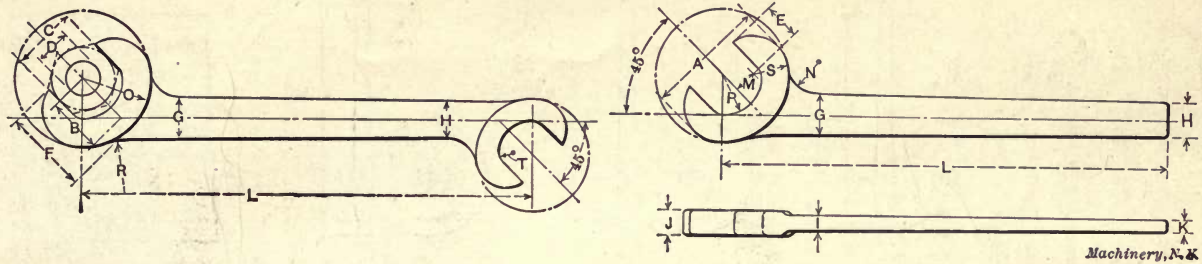


Fig. 4.

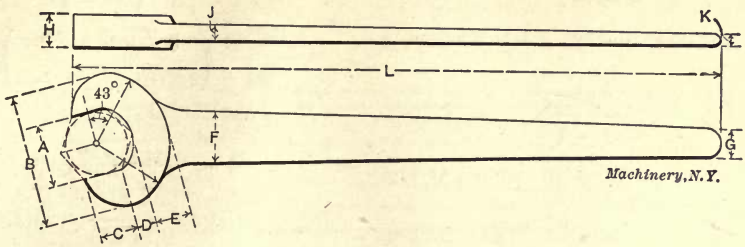
DIMENSIONS OF WRENCHES—I



Diam. of Bolt D	Width of Jaws C		A	B	E	F	G	H	I	J	K	L	M	N	O	P	R	S	T
	Max.	Min.																	
1/4	0.530	0.527	1.06	0.47	0.32	0.74	0.39	0.31	0.14	0.21	0.12	5	0.19	0.33	0.59	0.33	0.94	0.33	0.06
5/16	0.605	0.602	1.21	0.54	0.37	0.85	0.45	0.39	0.16	0.24	0.14	5	0.22	0.37	0.68	0.37	1.08	0.37	0.07
3/8	0.715	0.712	1.43	0.64	0.43	1.00	0.53	0.47	0.19	0.28	0.17	6	0.26	0.44	0.80	0.44	1.28	0.44	0.08
7/16	0.825	0.822	1.65	0.73	0.50	1.16	0.61	0.54	0.22	0.33	0.19	6	0.30	0.51	0.92	0.51	1.47	0.51	0.10
1/2	0.925	0.922	1.85	0.82	0.56	1.30	0.69	0.60	0.24	0.37	0.22	8	0.34	0.57	1.04	0.57	1.65	0.57	0.11
9/16	1.015	1.012	2.03	0.90	0.62	1.43	0.75	1.66	0.27	0.40	0.24	8	0.38	0.63	1.14	0.63	1.81	0.63	0.12
5/8	1.105	1.102	2.21	0.99	0.67	1.55	0.82	0.72	0.29	0.44	0.26	9	0.41	0.69	1.24	0.69	1.97	0.69	0.13
11/16	1.205	1.202	2.41	1.08	0.74	1.69	0.89	0.79	0.32	0.48	0.28	9	0.45	0.75	1.35	0.75	2.15	0.75	0.15
3/4	1.305	1.302	2.61	1.16	0.80	1.84	0.97	0.85	0.35	0.52	0.31	10	0.48	0.81	1.46	0.81	2.33	0.81	0.16
13/16	1.395	1.392	2.79	1.25	0.85	1.96	1.04	0.91	0.37	0.55	0.33	10	0.52	0.87	1.56	0.87	2.49	0.87	0.17
7/8	1.485	1.482	2.97	1.33	0.91	2.09	1.10	0.97	0.39	0.59	0.35	12	0.55	0.92	1.67	0.92	2.65	0.93	0.18
15/16	1.585	1.582	3.17	1.42	0.97	2.23	1.18	1.04	0.42	0.63	0.37	12	0.59	0.99	1.78	0.99	2.83	0.99	0.19
1	1.675	1.672	3.35	1.50	1.02	2.36	1.25	1.10	0.44	0.67	0.39	15	0.62	1.04	1.88	1.04	2.99	1.04	0.20
1 1/8	1.870	1.864	3.74	1.67	1.14	2.63	1.39	1.22	0.50	0.74	0.44	15	0.69	1.16	2.10	1.16	3.34	1.17	0.23
1 1/4	2.060	2.054	4.12	1.84	1.26	2.90	1.53	1.35	0.55	0.82	0.49	18	0.77	1.28	2.31	1.28	3.68	1.29	0.25
1 3/8	2.230	2.224	4.46	1.99	1.36	3.14	1.66	1.46	0.59	0.89	0.53	18	0.83	1.39	2.50	1.39	3.99	1.39	0.27
1 1/2	2.420	2.414	4.84	2.16	1.48	3.41	1.80	1.59	0.64	0.96	0.57	21	0.90	1.51	2.72	1.51	4.33	1.51	0.30
1 5/8	2.590	2.584	5.18	2.32	1.59	3.65	1.93	1.70	0.69	1.03	0.61	21	0.96	1.61	2.91	1.61	4.63	1.62	0.32
1 3/4	2.770	1.764	5.54	2.48	1.70	3.90	2.06	1.82	0.74	1.10	0.65	23	1.03	1.73	3.11	1.73	4.95	1.73	0.34
1 7/8	3.030	3.024	6.06	2.71	1.86	4.27	2.26	1.99	0.81	1.21	0.72	23	1.13	1.89	3.40	1.89	5.42	1.89	0.37
2	3.160	3.154	6.32	2.83	1.94	4.45	2.35	2.07	0.84	1.26	0.75	26	1.18	1.97	3.55	1.97	5.65	1.97	0.39

Explanatory note: Page 44.

DIMENSIONS OF WRENCHES—II



Bolt Diam.	A	B	C	D	E	F	G	H	J	K	L
1/4	1/2	1	1/4	1/8	1/4	1/2	3/4	1/4	1/4	1/4	5 1/2
5/16	19/32	1 3/16	5/16	5/32	5/16	9/16	3/4	5/16	5/16	5/16	6
3/8	11/16	1 3/8	3/8	3/16	3/8	5/8	3/4	3/8	5/16	5/16	7
7/16	25/32	1 9/16	7/16	7/32	7/16	11/16	3/4	7/16	5/16	5/16	8
1/2	7/8	1 3/4	1/2	1/4	1/2	3/4	7/8	1/2	5/16	5/16	9
9/16	31/32	1 15/16	9/16	9/32	9/16	7/8	7/8	9/16	5/16	5/16	10
5/8	1 1/16	2 1/8	5/8	5/16	5/8	1	7/8	5/8	3/8	3/8	11
3/4	1 1/4	2 1/2	3/4	3/8	3/4	1 1/8	1	11/16	3/8	3/8	12 1/2
7/8	1 7/16	2 15/16	13/16	7/16	13/16	1 5/16	1	3/4	7/16	3/8	14 1/2
1	1 5/8	3 5/16	15/16	1/2	15/16	1 1/2	1	7/8	1/2	3/8	16 1/2
1 1/8	1 13/16	3 11/16	1 1/16	9/16	1 1/16	1 5/8	1 1/16	15/16	1/2	7/16	18
1 1/4	2	4 1/16	1 1/8	9/16	1 1/8	1 3/4	1 1/16	1	9/16	7/16	20
1 3/8	2 3/16	4 7/16	1 1/4	5/8	1 1/4	1 7/8	1 1/8	1 1/8	5/8	7/16	22
1 1/2	2 3/8	4 13/16	1 3/8	11/16	1 3/8	2	1 1/8	1 1/4	5/8	1/2	24
1 5/8	2 9/16	5 3/16	1 1/2	3/4	1 1/2	2 1/4	1 3/16	1 1/4	11/16	1/2	26
1 3/4	2 3/4	5 9/16	1 5/8	13/16	1 5/8	2 3/8	1 3/16	1 3/8	11/16	1/2	28
1 7/8	2 15/16	6	1 11/16	7/8	1 11/16	2 1/2	1 1/4	1 3/8	3/4	9/16	30
2	3 1/8	6 3/8	1 13/16	15/16	1 13/16	2 5/8	1 1/4	1 1/2	3/4	9/16	33
2 1/4	3 1/2	7 1/8	2	1	2	3	1 5/16	1 5/8	7/8	5/8	35
2 1/2	3 7/8	7 7/8	2 1/4	1 1/8	2 1/4	3 1/4	1 3/8	1 3/4	1	5/8	39
2 3/4	4 1/4	8 5/8	2 1/2	1 1/4	2 1/2	3 9/16	1 7/16	1 7/8	1	11/16	42
3	4 5/8	9 3/8	2 11/16	1 3/8	2 11/16	3 7/8	1 1/2	2	1 1/8	11/16	46
3 1/4	5	10 1/8	2 7/8	1 7/16	2 7/8	4 1/8	1 9/16	2 1/8	1 3/16	3/4	50
3 1/2	5 3/8	10 7/8	3 1/8	1 9/16	3 1/8	4 1/2	1 5/8	2 1/4	1 1/4	3/4	53
3 3/4	5 3/4	11 11/16	3 5/16	1 11/16	3 5/16	4 3/4	1 11/16	2 3/8	1 5/16	13/16	57
4	6 1/8	12 3/8	3 1/2	1 3/4	3 1/2	5	1 3/4	2 1/2	1 3/8	7/8	60

Contributed by Wm. C. Davids.

the tension in that part of the band marked x equals

$$P\frac{1}{e^{\mu\theta}-1}.$$

The tension in that part marked y equals

$$P\frac{e^{\mu\theta}}{e^{\mu\theta}-1}.$$

P = tangential force in pounds at rim of brake wheel,

e = base of natural logarithms = 2.71828,

μ = coefficient of friction between the brake band and the brake wheel,

θ = angle of contact of the brake band with the brake wheel expressed in radians (one radian $= \frac{180 \text{ deg.}}{\pi} = 57.296$ degrees).

For simplicity in the formulas presented, the tensions at x and y (Fig. 1, page 24) are denoted T_1 and T_2 respectively, for clockwise rotation. When the direction of the rotation is reversed, the tension in x equals T_2, and the tension in y equals T_1, which is the reverse of the tension in the clockwise direction.

The value of the expression $e^{\mu\theta}$ occuring in these formulas may be most easily solved by means of logarithms. The value of $e^{\mu\theta}$ is found by multiplying the logarithm of e by the product of the numerical values of μ and θ, and finding the number whose logarithm is equal to the result of this multiplication. The procedure may be best illustrated by an example.

In a band brake of the type in Fig. 1, page 24, dimension $a = 24$ inches, and $b = 4$ inches; force $P = 100$ pounds; coefficient $\mu = 0.2$, and angle of contact = 240 degrees, or

$$\theta = \frac{240}{180} \times \pi = 4.18.$$

The rotation is clockwise. Find force F required.

$$F = \frac{Pb}{a}\left(\frac{e^{\mu\theta}}{e^{\mu\theta}-1}\right) =$$

$$\frac{100\times 4}{24}\left(\frac{2.71828^{0.2\times 4.18}}{2.71828^{0.2\times 4.18}-1}\right) =$$

$$\frac{400}{24} \times \frac{2.71828^{0.836}}{2.71828^{0.836}-1} =$$

$$16.16 \times \frac{2.31}{2.31-1} = 29.4.$$

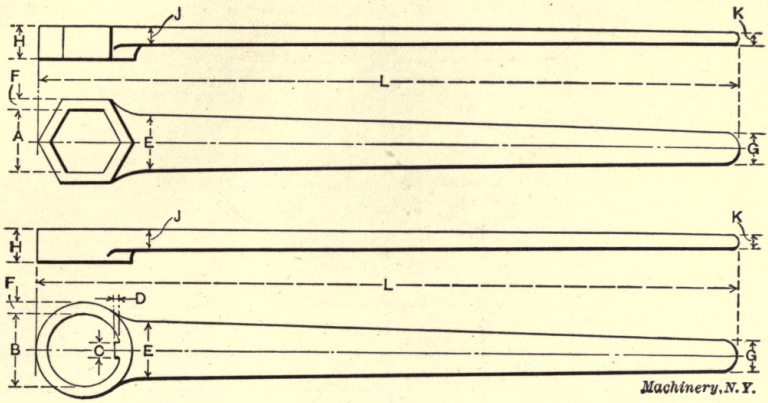
The calculations for determining the value of $e^{\mu\theta}$ are rather cumbersome, and the accompanying table is appended in order to save calculations.

TABLE OF VALUES OF $e^{\mu\theta}$.

Proportion of Contact to Whole Circumference, $\frac{\theta}{2\pi}$	Steel Band on Cast Iron, $\mu = 0.18$	Leather Belt on			
		Wood	Cast Iron		
		Slightly Greasy. $\mu = 0.47$	Very Greasy. $\mu = 0.12$	Slightly Greasy. $\mu = 0.28$	Damp. $\mu = 0.38$
0.1	1.12	1.34	1.01	1.19	1.27
0.2	1.25	1.81	1.16	1.42	1.61
0.3	1.40	2.43	1.25	1.69	2.05
0.4	1.57	3.26	1.35	2.02	2.60
0.425	1.62	3.51	1.38	2.11	2.76
0.45	1.66	3.78	1.40	2.21	2.93
0.475	1.71	4.07	1.43	2.31	3.11
0.5	1.76	4.38	1.46	2.41	3.30
0.525	1.81	4.71	1.49	2.52	3.50
0.55	1.86	5.63	1.51	2.63	3.72
0.6	1.97	5.88	1.57	2.81	4.19
0.7	2.21	7.90	1.66	3.43	5.32
0.8	2.47	10.60	1.83	4.09	6.75
0.9	2.77	14.30	1.97	4.87	8.57
1.0	3.10	19.20	2.12	5.81	10.90
1.5	5.45	.....	...	....	.....
2.0	9.60	.....	....	....	.....
2.5	16.90	.....	....	....	.....
3.0	29.80	.....	....	....	.....
3.5	52.40	....	...	...	.. .

[MACHINERY, January, 1901, Band Brakes; March, 1905, More Notes on Band Brake Design; August, September, October, November, 1906, Brakes.]

DIMENSIONS OF BOX WRENCHES

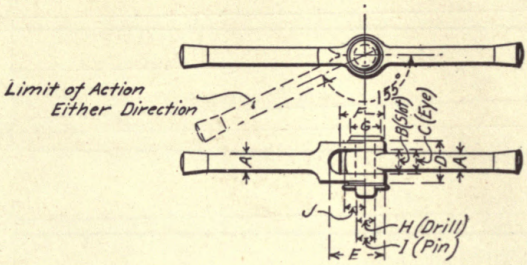


Bolt Diam.	A	B	C	D	E	F	G	H	J	K	L
$1\frac{1}{2}$	$2\frac{3}{8}$	$2\frac{3}{4}$	$\frac{7}{16}$	$\frac{3}{16}$	$2\frac{1}{8}$	$\frac{3}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	26
$1\frac{5}{8}$	$2\frac{9}{16}$	3	$\frac{7}{16}$	$\frac{3}{16}$	$2\frac{1}{4}$	$\frac{7}{16}$	$1\frac{3}{16}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	28
$1\frac{3}{4}$	$2\frac{3}{4}$	$3\frac{1}{8}$	$\frac{7}{16}$	$\frac{3}{16}$	$2\frac{3}{8}$	$\frac{7}{16}$	$1\frac{3}{16}$	$1\frac{3}{8}$	$\frac{13}{16}$	$\frac{1}{2}$	30
$1\frac{7}{8}$	$2\frac{15}{16}$	$3\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{16}$	$2\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$\frac{13}{16}$	$\frac{9}{16}$	32
2	$3\frac{1}{8}$	$3\frac{5}{8}$	$\frac{1}{2}$	$\frac{3}{16}$	$2\frac{5}{8}$	$\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$\frac{7}{8}$	$\frac{9}{16}$	33
$2\frac{1}{4}$	$3\frac{1}{2}$	4	$\frac{9}{16}$	$\frac{1}{4}$	$2\frac{3}{4}$	$\frac{9}{16}$	$1\frac{5}{16}$	$1\frac{5}{8}$	$\frac{15}{16}$	$\frac{5}{8}$	38
$2\frac{1}{2}$	$3\frac{7}{8}$	$4\frac{3}{8}$	$\frac{9}{16}$	$\frac{1}{4}$	3	$\frac{5}{8}$	$1\frac{3}{8}$	$1\frac{3}{4}$	1	$\frac{5}{8}$	42
$2\frac{3}{4}$	$4\frac{1}{4}$	$4\frac{7}{8}$	$\frac{5}{8}$	$\frac{1}{4}$	$3\frac{1}{4}$	$\frac{5}{8}$	$1\frac{7}{16}$	$1\frac{7}{8}$	1	$\frac{11}{16}$	45
3	$4\frac{5}{8}$	$5\frac{1}{4}$	$\frac{11}{16}$	$\frac{1}{4}$	$3\frac{1}{2}$	$\frac{11}{16}$	$1\frac{1}{2}$	2	$1\frac{1}{8}$	$\frac{11}{16}$	49
$3\frac{1}{4}$	5	$5\frac{5}{8}$	$\frac{3}{4}$	$\frac{5}{16}$	$3\frac{3}{4}$	$\frac{3}{4}$	$1\frac{9}{16}$	$2\frac{1}{8}$	$1\frac{1}{8}$	$\frac{3}{4}$	54
$3\frac{1}{2}$	$5\frac{3}{8}$	$6\frac{1}{8}$	$\frac{3}{4}$	$\frac{5}{16}$	4	$\frac{3}{4}$	$1\frac{5}{8}$	$2\frac{1}{4}$	$1\frac{1}{4}$	$\frac{3}{4}$	57
$3\frac{3}{4}$	$5\frac{3}{4}$	$6\frac{1}{2}$	$\frac{13}{16}$	$\frac{5}{16}$	$4\frac{1}{4}$	$\frac{13}{16}$	$1\frac{11}{16}$	$2\frac{3}{8}$	$1\frac{1}{4}$	$\frac{13}{16}$	61
4	$6\frac{1}{8}$	$6\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$4\frac{3}{8}$	$\frac{7}{8}$	$1\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$\frac{7}{8}$	64

Contributed by Wm. C. Davids.

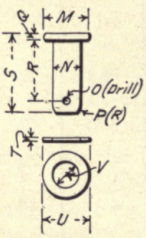
A. L. A. M. STANDARD YOKE AND ROD ENDS

A. L. A. M. Standard Solid Yoke and Eye Rod Ends



Rod A	Slot B	Eye C	D	E	F	G	Drill H	Pin I	J
1/4	7/16	0.432	3/4	1 1/32	25/32	1/2	5/16	0.310	5/8
5/16	1/2	0.495	7/8	1 7/32	15/16	5/8	13/32	0.403	7/16
3/8	19/32	0.588	1	1 3/8	1 1/16	3/4	15/32	0.465	1/2
7/16	21/32	0.651	1 1/8	1 9/16	1 5/32	7/8	9/16	0.559	17/32
1/2	3/4	0.745	1 1/4	1 11/16	1 5/16	15/16	5/8	0.621	5/8

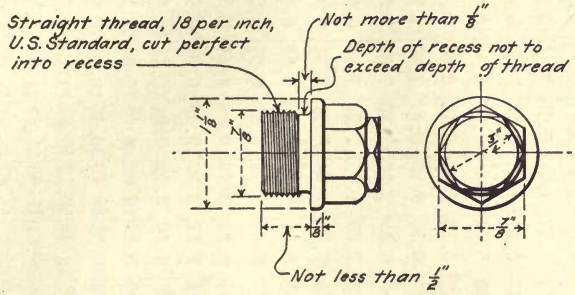
A. L. A. M. Standard Pin and Washer Dimensions



Size Rod	1/4	5/16	3/8	7/16	1/2
M	1/2	5/8	3/4	7/8	15/16
N	0.310	0.403	0.465	0.559	0.621
O	5/64	5/64	7/64	9/64	11/64
P	5/16	13/32	15/32	9/16	5/8
Q	3/32	3/32	1/8	1/8	1/8
R	53/64	61/64	1 3/32	1 17/64	1 3/8
S	1 3/32	1 1/4	1 7/16	1 5/8	1 3/4
T	1/32	1/32	1/32	1/16	1/16
U	1/2	5/8	3/4	7/8	1
V	5/16	13/32	15/32	9/16	5/8

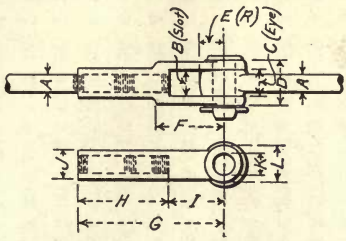
A. L. A. M. STANDARD SPARK PLUG AND YOKE AND ROD ENDS

A. L. A. M. Standard Spark Plug



Association of Licensed Automobile Manufacturers Standard Threads, Screws, Castle and Plain Nuts:—See MACHINERY'S Data Sheet Book No. 2.

A.L.A.M. Standard Adjustable Yoke and Eye Rod Ends



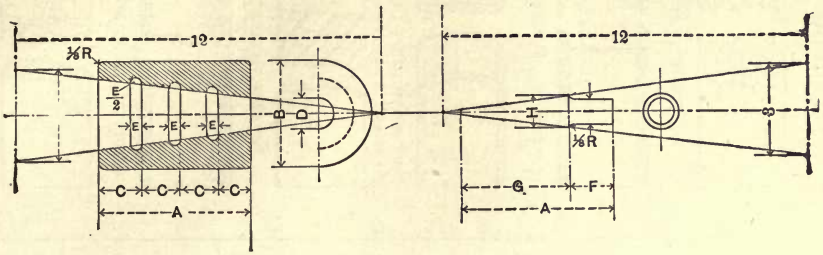
Rod A	Thread	Slot B	Eye C	D	E	F	G	H	I	J	K	L
1/4	1/4 X 28	7/16	0.432	3/4	3/8	1 1/4	2 3/8	1 3/8	1	1/2	5/16	11/16
5/16	5/16 X 24	1/2	0.495	7/8	7/16	1 3/8	2 3/4	1 5/8	1 1/8	9/16	13/32	3/4
3/8	3/8 X 24	19/32	0.588	1	1/2	1 1/2	3 1/8	1 7/8	1 1/4	21/32	15/32	7/8
7/16	7/16 X 20	21/32	0.651	1 1/8	17/32	1 11/16	3 5/8	2 1/4	1 3/8	3/4	9/16	15/16
1/2	1/2 X 20	3/4	0.770	1 1/4	5/8	1 7/8	4	2 1/2	1 1/2	13/16	5/8	1 1/16

DIAMETERS OF BLANKS FOR DRAWN SHELLS

Diameter	Height of Shells																							
	¼	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾	6
¼	.56	.75	.90	1.03	1.14	1.25	1.35	1.44	1.52	1.60	1.68	1.75	1.82	1.89	1.95	2.01	2.08	2.14	2.19	2.25	2.30	2.36	2.41	2.46
½	.87	1.12	1.32	1.50	1.66	1.80	1.94	2.06	2.18	2.29	2.40	2.50	2.60	2.69	2.78	2.87	2.96	3.04	3.12	3.21	3.29	3.36	3.44	3.50
¾	1.14	1.44	1.68	1.89	2.08	2.25	2.41	2.56	2.70	2.84	2.97	3.09	3.21	3.33	3.44	3.54	3.65	3.75	3.85	3.95	4.04	4.13	4.22	4.31
1	1.41	1.73	2.00	2.24	2.45	2.65	2.83	3.00	3.16	3.32	3.46	3.61	3.74	3.87	4.00	4.12	4.24	4.36	4.47	4.58	4.69	4.80	4.90	5.00
1¼	1.68	2.01	2.30	2.56	2.79	3.01	3.21	3.40	3.58	3.75	3.91	4.07	4.22	4.37	4.51	4.64	4.77	4.91	5.03	5.15	5.27	5.39	5.50	5.62
1½	1.94	2.29	2.60	2.87	3.12	3.36	3.57	3.78	3.97	4.15	4.33	4.50	4.66	4.82	4.98	5.12	5.27	5.41	5.55	5.68	5.81	5.94	6.06	6.18
1¾	2.19	2.56	2.88	3.17	3.44	3.68	3.91	4.13	4.34	4.53	4.72	4.91	5.08	5.26	5.41	5.58	5.73	5.88	6.03	6.17	6.31	6.45	6.58	6.71
2	2.45	2.83	3.16	3.46	3.74	4.00	4.24	4.47	4.69	4.90	5.10	5.29	5.48	5.66	5.83	6.00	6.16	6.32	6.48	6.63	6.78	6.93	7.07	7.21
2¼	2.70	3.09	3.44	3.75	4.04	4.31	4.56	4.80	5.03	5.25	5.46	5.66	5.86	6.05	6.23	6.41	6.58	6.75	6.91	7.07	7.23	7.39	7.54	7.69
2½	2.96	3.36	3.71	4.03	4.33	4.61	4.87	5.12	5.36	5.59	5.81	6.02	6.22	6.42	6.61	6.80	6.98	7.16	7.33	7.50	7.66	7.82	7.98	8.14
2¾	3.21	3.61	3.98	4.31	4.62	4.91	5.18	5.44	5.68	5.92	6.15	6.37	6.58	6.79	6.99	7.18	7.37	7.55	7.73	7.91	8.08	8.25	8.41	8.58
3	3.46	3.87	4.24	4.58	4.90	5.20	5.48	5.74	6.00	6.25	6.48	6.71	6.93	7.14	7.35	7.55	7.75	7.94	8.12	8.31	8.49	8.66	8.83	9.00
3¼	3.71	4.13	4.51	4.85	5.18	5.48	5.77	6.04	6.31	6.56	6.80	7.04	7.27	7.49	7.70	7.91	8.11	8.31	8.50	8.69	8.88	9.06	9.24	9.41
3½	3.97	4.39	4.77	5.12	5.45	5.77	6.06	6.34	6.61	6.87	7.12	7.36	7.60	7.83	8.05	8.26	8.47	8.67	8.87	9.07	9.26	9.45	9.63	9.81
3¾	4.22	4.64	5.03	5.39	5.73	6.05	6.35	6.64	6.91	7.18	7.44	7.69	7.92	8.16	8.38	8.61	8.82	9.03	9.24	9.44	9.63	9.83	10.02	10.20
4	4.47	4.90	5.29	5.66	6.00	6.32	6.63	6.93	7.21	7.48	7.75	8.00	8.25	8.49	8.72	8.94	9.17	9.38	9.59	9.80	10.00	10.20	10.39	10.58
4¼	4.72	5.15	5.55	5.92	6.27	6.60	6.91	7.22	7.50	7.78	8.05	8.31	8.56	8.81	9.04	9.28	9.50	9.72	9.94	10.15	10.36	10.56	10.76	10.96
4½	4.98	5.41	5.81	6.19	6.54	6.87	7.19	7.50	7.79	8.08	8.35	8.62	8.87	9.12	9.37	9.60	9.84	10.06	10.28	10.50	10.71	10.92	11.12	11.32
4¾	5.22	5.66	6.07	6.45	6.80	7.15	7.47	7.78	8.08	8.37	8.65	8.92	9.18	9.44	9.69	9.93	10.16	10.40	10.62	10.84	11.06	11.27	11.48	11.69
5	5.48	5.92	6.32	6.71	7.07	7.42	7.75	8.06	8.37	8.66	8.94	9.22	9.49	9.75	10.00	10.25	10.49	10.72	10.95	11.18	11.40	11.62	11.83	12.04
5¼	5.73	6.17	6.58	6.97	7.33	7.68	8.02	8.34	8.65	8.95	9.24	9.52	9.79	10.05	10.31	10.56	10.81	11.05	11.28	11.51	11.74	11.96	12.18	12.39
5½	5.98	6.42	6.84	7.23	7.60	7.95	8.29	8.62	8.93	9.23	9.53	9.81	10.08	10.36	10.62	10.87	11.12	11.37	11.61	11.84	12.07	12.30	12.52	12.74
5¾	6.23	6.68	7.09	7.49	7.86	8.22	8.56	8.89	9.21	9.52	9.81	10.10	10.38	10.66	10.92	11.18	11.44	11.69	11.93	12.17	12.40	12.63	12.85	13.08
6	6.48	6.93	7.35	7.75	8.12	8.49	8.83	9.17	9.49	9.80	10.10	10.39	10.68	10.95	11.23	11.49	11.75	12.00	12.25	12.49	12.73	12.96	13.19	13.42

Contributed by C. P. MacArthur. Explanatory note: Page 44.

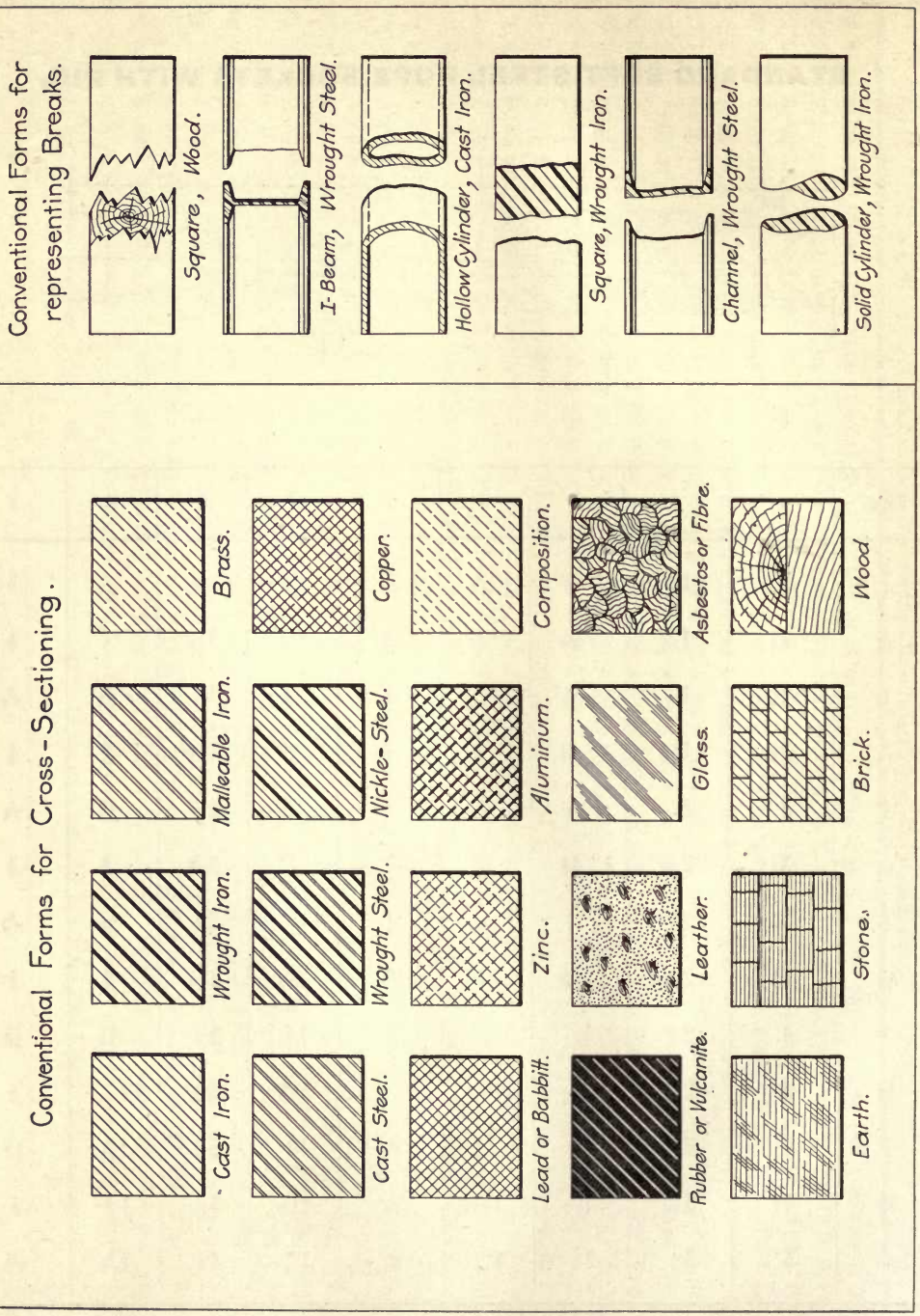
STANDARD SOFT STEEL ROPE SOCKETS WITH PIN.



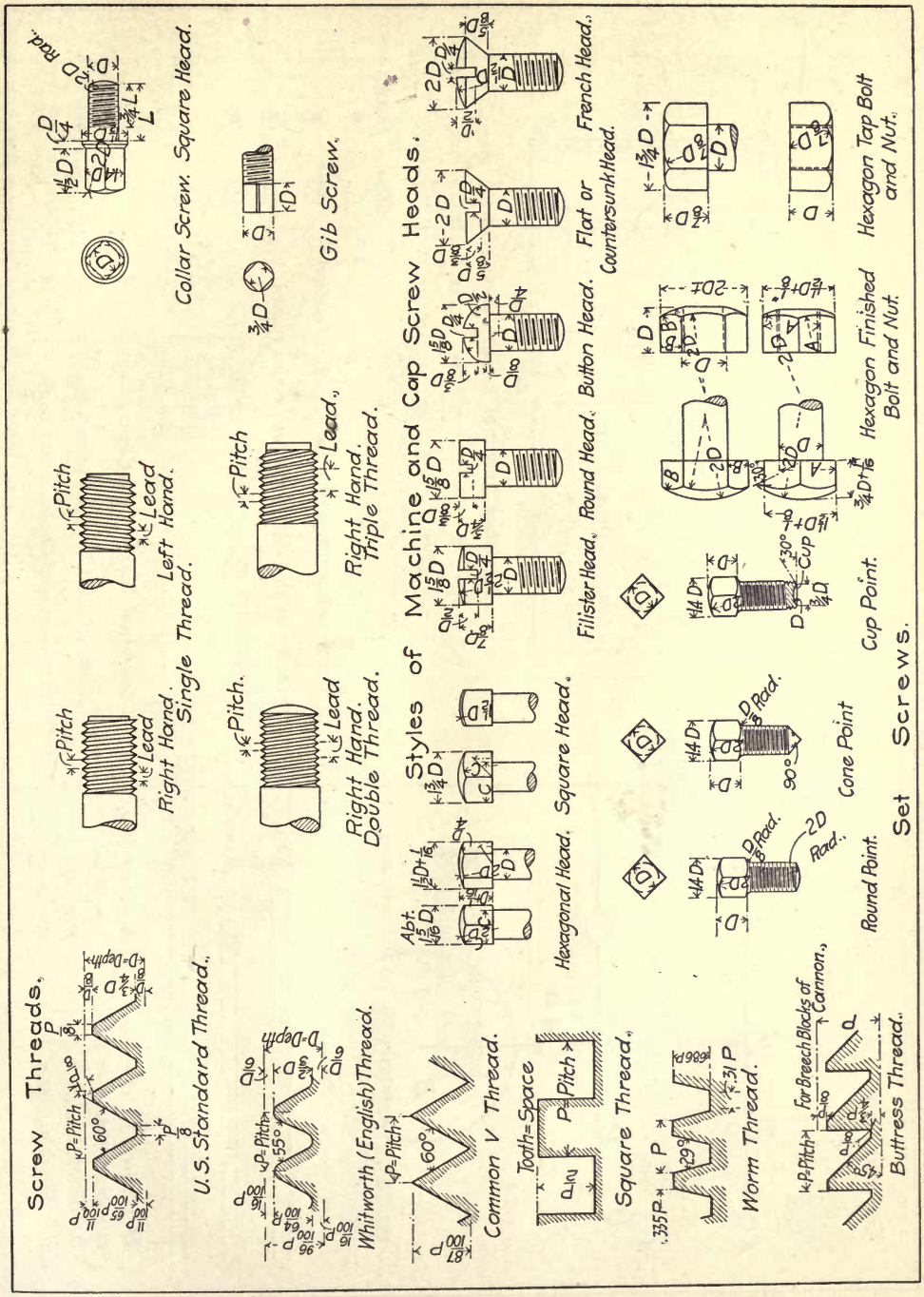
Rope.	A	B	C	D	E	F	G	H	I
1/4	2	1 1/4	1/2	5/16	3/16	5/8	1 3/8	7/16	1/4
5/16	2 1/4	1 7/16	9/16	3/8	3/16	11/16	1 9/16	1/2	1/4
3/8	2 1/2	1 5/8	5/8	7/16	1/4	3/4	1 3/4	9/16	5/16
7/16	2 3/4	1 13/16	11/16	1/2	1/4	13/16	1 15/16	5/8	3/8
1/2	3	2	3/4	9/16	1/4	7/8	2 1/8	11/16	7/16
9/16	3 1/4	2 3/16	13/16	5/8	1/4	15/16	2 5/16	3/4	1/2
5/8	3 1/2	2 3/8	7/8	11/16	1/4	1	2 1/2	13/16	9/16
11/16	3 3/4	2 9/16	15/16	3/4	5/16	1 1/16	2 11/16	7/8	5/8
3/4	4	2 3/4	1	13/16	5/16	1 1/8	2 7/8	15/16	11/16
13/16	4 1/4	2 15/16	1 1/16	7/8	5/16	1 3/16	3 1/16	1	3/4
7/8	4 1/2	3 1/8	1 1/8	15/16	5/16	1 1/4	3 1/4	1 1/16	13/16
15/16	4 3/4	3 5/16	1 3/16	1	5/16	1 5/16	3 7/16	1 1/8	7/8
1	5	3 1/2	1 1/4	1 1/16	5/16	1 3/8	3 5/8	1 3/16	15/16

Contributed by R. A. Greene, MACHINERY'S Data Sheet No. 30. Explanatory note: Page 44.

DRAFTING-ROOM CONVENTIONS FOR CROSS-SECTIONING



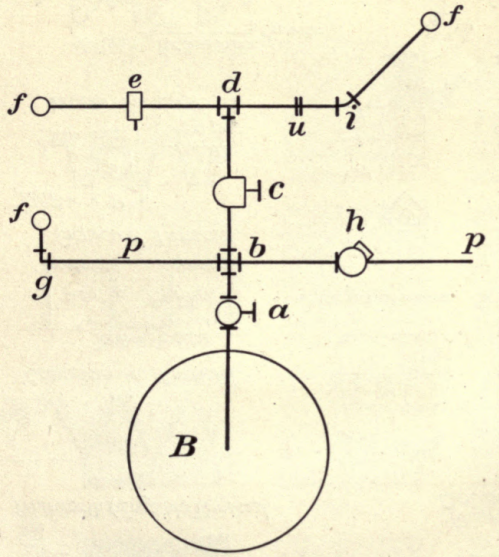
DRAFTING-ROOM CONVENTIONS FOR SCREWS AND SCREW THREADS



MACHINERY'S Data Sheet No. 15. Explanatory note: Page 44.

DRAFTING-ROOM CONVENTIONS FOR PIPE FITTINGS AND RIVETING

Conventional Pipe Fittings.



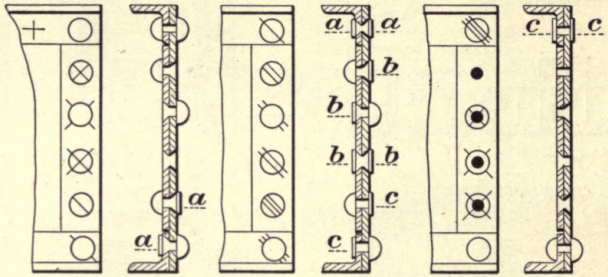
Main.

Return.

Drip.

B = Boiler.	**d** = Tee.	**h** = Check Valve.
a = Globe Valve.	**e** = Cock.	**i** = 45° Elbow.
b = Cross.	**f** = Risers.	**p** = Pipe.
c = Gate Valve.	**g** = Elbow.	**u** = Union.

Conventional Signs for Riveting.

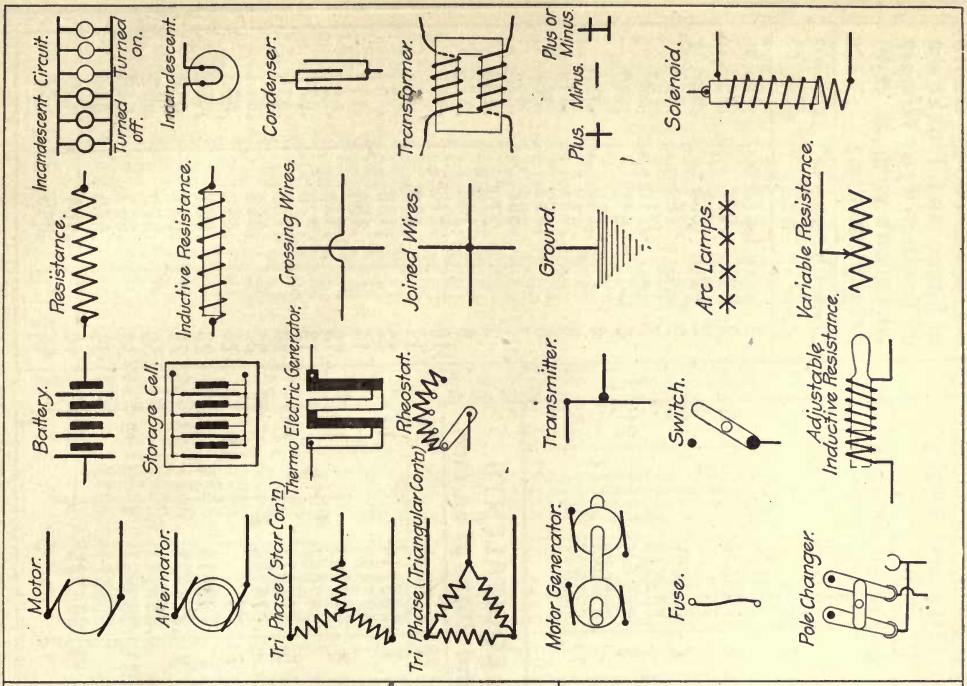


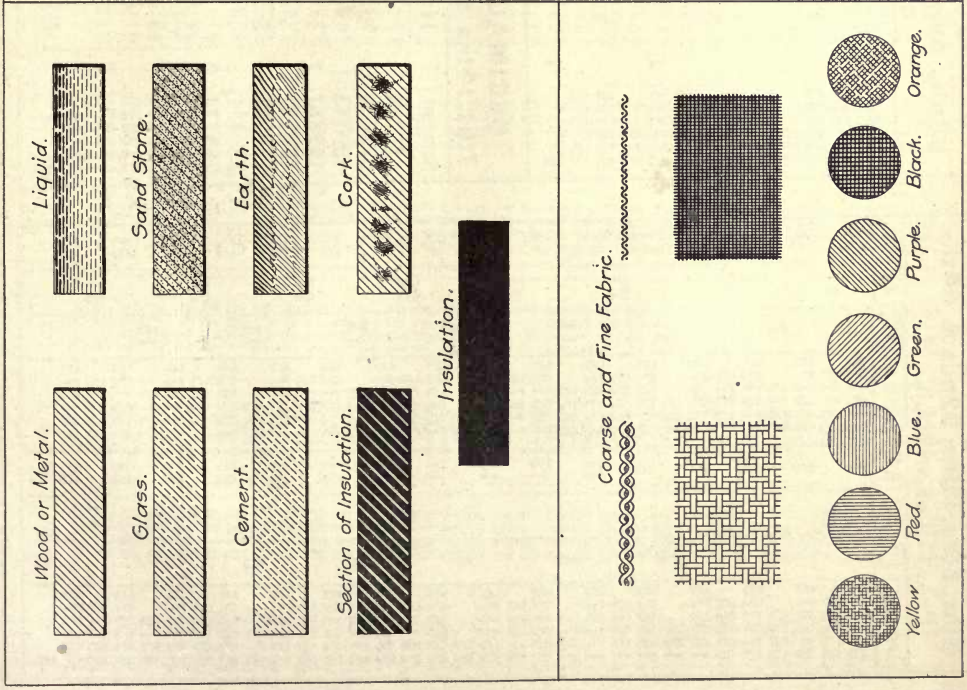
Maximum height of heads marked **a** = $\frac{1}{8}$" inch.
" " " " " **b** = $\frac{1}{4}$" inch.
" " " " " **c** = $\frac{3}{8}$" inch.

		Shop	Field.
Two full heads	+ or	○	●
Countersunk and chipped other side (or side not visible.)		⊗	⊗
Countersunk and chipped this side (or side visible.)		⊗	⊗
Countersunk and chipped both sides.		⊗	⊗
	Other side (Not visible)	This side (Visible)	Both Sides.
Countersunk but not chipped limit $\frac{1}{8}$" high.		⌀	⌀
Flattened head $\frac{1}{4}$" high and countersunk	$\frac{1}{4}$"	⌀	⌀
Flattened head $\frac{3}{8}$" high and not countersunk		⌀	⌀

From Jones & Laughlins' Hand-book on Steel Construction.

CONVENTIONS REQUIRED FOR USE ON UNITED STATES PATENT OFFICE DRAWINGS





MACHINERY'S Data Sheet No. 15. Explanatory note: Page 44.

DECIMAL EQUIVALENTS.
4ths, 8ths, 16ths, 32nds & 64ths of an inch.

Decimal.	16	32	64	Decimal.	16	32	64
.015625			1	.515625			33
.03125		1		.53125		17	
.046875			3	.546875			35
.0625	1			.5625	9		
.078125			5	.578125			37
.09375		3		.59375		19	
.109375			7	.609375			39
.125	2			.625	10		
.140625			9	.640625			41
.15625		5		.65625		21	
.171875			11	.671875			43
.1875	3			.6875	11		
.203125			13	.703125			45
.21875		7		.71875		23	
.234375			15	.734375			47
.25	4			.75	12		
.265625			17	.765625			49
.28125		9		.78125		25	
.296875			19	.796875			51
.3125	5			.8125	13		
.328125			21	.828125			53
.34375		11		.84375		27	
.359375			23	.859375			55
.375	6			.875	14		
.390625			25	.890625			57
.40625		13		.90625		29	
.421875			27	.921875			59
.4375	7			.9375	15		
.453125			29	.953125			61
.46875		15		.96875		31	
.484375			31	.984375			63
.5	8						

DECIMAL EQUIVALENTS.
3rds, 6ths, 12ths and 24ths of an inch.

Decimal.	6	12	24	Decimal.	6	12	24
.041667			1	.541666			13
.083333		1		.583333		7	
.125			3	.625			15
.166666	1			.666666	4		
.208333			5	.708333			17
.25		3		.75		9	
.291666			7	.791666			19
.333333	2			.833333	5		
.375			9	.875			21
.416666		5		.916666		11	
.458333			11	.958333			23
.5	3						

DECIMAL EQUIVALENTS.
7ths, 14ths and 28ths of an inch.

Decimal.	7	14	28	Decimal.	7	14	28
.035714			1	.535714			15
.071429		1		.571429	4		
.107143			3	.607143			17
.142857	1			.642867		9	
.178571			5	.678571			19
.214286		3		.714286	5		
.25			7	.75			21
.285714	2			.785714		11	
.321429			9	.821429			23
.357143		5		.857143	6		
.392857			11	.892857			25
.428571	3			.928571		13	
.464286			13	.964286			27
.5		7					

Table showing Depth of Space and Thickness of Tooth in Spur Wheels when cut with B. & S. patent cutters.

Pitch of Cutter	Depth to be Cut in Gear	Thickness of Tooth at Pitch Line.
2	1.078 in.	.785 in.
2 1-4	.958	.697
2 1-2	.863	.628
2 3-4	.784	.570
3	.719	.523
3 1-2	.616	.448
4	.539	.393
5	.431	.314
6	.359	.262
7	.308	.224
8	.270	.196
9	.240	.175
10	.216	.157
11	.196	.143
12	.180	.131
14	.154	.112
16	.135	.098
18	.120	.087
20	.108	.079
22	.098	.071
24	.090	.065
26	.083	.060
28	.077	.056
30	.072	.052
32	.067	.049
36	.060	.044
40	.054	.039
48	.045	.033

INCHES TO DECIMALS OF A FOOT.

	0	1	2	3	4	5	6	7	8	9	10	11
..	....	0833	1667	2500	3333	4167	5000	5833	6667	7500	8333	9167
1/32	0026	0859	1693	2526	3359	4193	5026	5859	6693	7526	8359	9193
1/16	0052	0885	1719	2552	3385	4219	5052	5885	6719	7552	8385	9219
3/32	0078	0911	1745	2578	3411	4245	5078	5911	6745	7578	8411	9245
1/8	0104	0938	1771	2604	3438	4271	5104	5938	6771	7604	8438	9271
5/32	0130	0964	1797	2630	3464	4297	5130	5964	6797	7630	8464	9297
3/16	0156	0990	1823	2656	3490	4323	5156	5990	6823	7656	8490	9323
7/32	0182	1016	1849	2682	3516	4349	5182	6016	6849	7682	8516	9349
1/4	0208	1042	1875	2708	3542	4375	5208	6042	6875	7708	8542	9375
9/32	0234	1068	1901	2734	3568	4401	5234	6068	6901	7734	8568	9401
5/16	0260	1094	1927	2760	3594	4427	5260	6094	6927	7760	8594	9427
11/32	0286	1120	1953	2786	3620	4453	5286	6120	6953	7786	8620	9453
3/8	0313	1146	1979	2813	3646	4479	5313	6146	6979	7813	8646	9479
13/32	0339	1172	2005	2839	3672	4505	5339	6172	7005	7839	8672	9505
7/16	0365	1198	2031	2865	3698	4531	5365	6198	7031	7865	8698	9531
15/32	0391	1224	2057	2891	3724	4557	5391	6224	7057	7891	8724	9557
1/2	0417	1253	2083	2917	3750	4583	5417	6250	7083	7917	8750	9583
17/32	0443	1276	2109	2943	3776	4609	5443	6276	7109	7943	8776	9609
9/16	0469	1302	2135	2969	3802	4635	5469	6302	7135	7969	8802	9635
19/32	0495	1328	2161	2995	3828	4661	5495	6328	7161	7995	8828	9661
5/8	0521	1354	2188	3021	3854	4688	5521	6354	7188	8021	8854	9688
21/32	0547	1380	2214	3047	3880	4714	5547	6380	7214	8047	8880	9714
11/16	0573	1406	2240	3073	3906	4740	5573	6406	7240	8073	8906	9740
23/32	0599	1432	2266	3099	3932	4766	5599	6432	7266	8099	8932	9766
3/4	0625	1458	2292	3125	3958	4792	5625	6458	7292	8125	8958	9792
25/32	0651	1484	2318	3151	3984	4818	5651	6484	7318	8151	8984	9818
13/16	0677	1510	2344	3177	4010	4844	5677	6510	7344	8177	9010	9844
27/32	0703	1536	2370	3203	4036	4870	5703	6536	7370	8203	9036	9870
7/8	0729	1563	2396	3229	4063	4896	5729	6563	7396	8229	9063	9896
29/32	0755	1589	2422	3255	4089	4922	5755	6589	7422	8255	9089	9922
15/16	0781	1615	2448	3281	4115	4948	5781	6615	7448	8281	9115	9948
31/32	0807	1641	2474	3307	4141	4974	5807	6641	7474	8307	9141	9974

EQUIVALENTS OF INCHES IN MILLIMETERS.

		1	2	3	4	5	6	7	8	9	10	11	12
		25.3995	50.7990	76.1986	101.598	126.998	152.397	177.797	203.196	228.596	253.995	279.394	304.794
1/64	.3968	25.7964	51.1959	76.5954	101.995	127.394	152.794	178.193	203.593	228.992	254.392	279.791	305.191
1/32	.7937	26.1932	51.5928	76.9923	102.391	127.791	153.190	178.590	203.990	229.389	254.789	280.188	305.588
3/64	1.1906	26.5901	51.9896	77.3892	102.788	128.188	153.588	178.987	204.386	229.786	255.186	280.585	306.985
1/16	1.5874	26.9870	52.3865	77.7860	103.185	128.585	153.984	179.384	204.783	230.183	255.582	280.982	306.381
5/64	1.9843	27.3838	52.7834	78.1829	103.582	128.982	154.381	179.781	205.180	230.580	255.979	281.379	306.778
3/32	2.3812	27.7807	53.1802	78.5798	103.979	129.378	154.778	180.177	205.577	230.977	256.376	281.776	307.175
7/64	2.7780	28.1776	53.5771	78.9766	104.376	129.775	155.175	180.574	205.974	231.373	256.773	282.173	307.572
1/8	3.1749	28.5744	53.9740	79.3735	104.773	130.172	155.572	180.971	206.370	231.770	257.170	282.569	307.969
9/64	3.5718	28.9713	54.3708	79.7704	105.169	130.569	155.969	181.368	206.768	232.167	257.567	282.966	308.366
5/32	3.9686	29.3682	54.7677	80.1672	105.566	130.966	156.365	181.765	207.164	232.564	257.964	283.363	308.763
11/64	4.3655	29.7650	55.1646	80.5641	105.963	131.363	156.762	182.162	207.561	232.961	258.360	283.760	309.160
3/16	4.7624	30.1619	55.5614	80.9610	106.360	131.760	157.159	182.559	207.958	233.358	258.757	284.157	309.556
13/64	5.1592	30.5588	55.9583	81.3579	106.757	132.156	157.556	182.956	208.355	233.755	259.154	284.554	309.953
7/32	5.5561	30.9556	56.3552	81.7547	107.154	132.553	157.953	183.352	208.752	234.152	259.551	284.951	310.350
15/64	5.9530	31.3525	56.7520	82.1516	107.551	132.950	158.350	183.749	209.149	234.548	259.948	285.347	310.747
1/4	6.3498	31.7494	57.1489	82.5485	107.948	133.347	158.747	184.146	209.546	234.945	260.345	285.744	311.144
17/64	6.7467	32.1462	57.5458	82.9453	108.344	133.744	159.143	184.543	209.943	235.342	260.742	286.141	311.541
9/32	7.1436	32.5431	57.9426	83.3422	108.741	134.141	159.540	184.940	210.339	235.739	261.139	286.538	311.938
19/64	7.5404	32.9400	58.3395	83.7391	109.138	134.538	159.937	185.337	210.736	236.136	261.535	286.935	312.334
5/16	7.9373	33.3368	58.7364	84.1359	109.535	134.935	160.334	185.734	211.133	236.532	261.932	287.332	312.731
21/64	8.3342	33.7337	59.1333	84.5328	109.932	135.331	160.731	186.131	211.530	236.930	262.329	287.729	313.128
11/32	8.7310	34.1306	59.5301	84.9297	110.329	135.728	161.128	186.527	211.927	237.326	262.726	288.126	313.525
23/64	9.1279	34.5274	59.9270	85.3265	110.726	136.125	161.525	186.924	212.324	237.723	263.123	288.522	313.922
3/8	9.5248	34.9243	60.3239	85.7234	111.122	136.522	161.922	187.321	212.721	238.120	263.520	288.919	314.319
25/64	9.9216	35.3212	60.7207	86.1203	111.529	136.919	162.318	187.718	213.118	238.517	263.917	289.316	314.716
13/32	10.3185	35.7180	61.1176	86.5171	111.916	137.316	162.715	188.115	213.514	238.914	264.313	289.713	315.113
27/64	10.7154	36.1149	61.5145	86.9140	112.313	137.713	163.112	188.512	213.911	239.311	264.710	290.110	315.509
7/16	11.1122	36.5118	61.9113	87.3109	112.710	138.109	163.509	188.909	214.308	239.708	265.107	290.507	315.906
29/64	11.5091	36.9087	62.3082	87.7077	113.107	138.506	163.906	189.305	214.705	240.105	265.504	290.903	316.303
15/32	11.9060	37.3055	62.7051	88.1046	113.504	138.903	164.303	189.702	215.102	240.501	265.901	291.300	316.700
31/64	12.3029	37.7024	63.1019	88.5015	113.901	139.300	164.700	190.099	215.499	240.898	266.298	291.697	317.097

EQUIVALENTS OF INCHES IN MILLIMETERS (Continued).

		1	2	3	4	5	6	7	8	9	10	11	12
1/2	12.6997	38.0993	63.4988	88.8983	114.297	139.697	165.097	190.496	215.896	241.295	266.695	292.094	317.494
33/64	13.0966	38.4951	63.8957	89.2952	114.694	140.094	165.493	190.893	216.292	241.692	267.092	292.491	317.891
17/32	13.4934	38.8930	64.2925	89.6921	115.091	140.491	165.890	191.290	216.689	242.089	267.488	292.888	318.287
35/64	13.8903	39.2899	64.6894	90.0989	115.489	140.888	166.287	191.687	217.086	242.486	267.885	293.285	318.684
9/16	14.2872	39.6867	65.0863	90.4858	115.885	141.284	166.684	192.084	217.483	242.883	268.282	293.682	319.081
37/64	14.6841	40.0836	65.4831	90.8827	116.282	141.681	167.081	192.480	217.880	243.279	268.679	294.079	319.478
19/32	15.0809	40.4805	65.8800	91.2795	116.679	142.078	167.478	192.877	218.277	243.676	269.076	294.475	319.875
39/64	15.4778	40.8773	66.2769	91.6764	117.075	142.475	167.875	193.274	218.674	244.073	269.473	294.872	320.272
5/8	15.8747	41.2742	66.6737	92.0733	117.472	142.872	168.271	193.671	219.071	244.470	269.870	295.269	320.669
41/64	16.2715	41.6711	67.0706	92.4701	117.869	143.269	168.668	194.068	219.467	244.867	270.266	295.666	321.066
21/32	16.6684	42.0679	67.4675	92.8670	118.266	143.666	169.065	194.465	219.864	245.263	270.663	296.063	321.462
43/64	17.0653	42.4648	67.8643	93.2639	118.663	144.063	169.462	194.862	220.261	245.661	271.060	296.460	321.859
11/16	17.4621	42.8617	68.2612	93.6608	119.060	144.459	169.859	195.258	220.658	246.058	271.457	296.857	322.256
45/64	17.8590	43.2585	68.6581	94.0576	119.457	144.856	170.256	195.655	221.055	246.454	271.854	297.253	322.653
23/32	18.2559	43.6554	69.0549	94.4545	119.854	145.253	170.653	196.052	221.452	246.851	272.251	297.650	323.050
47/64	18.6527	44.0523	69.4518	94.8513	120.250	145.650	171.050	196.449	221.849	247.248	272.648	298.047	323.447
3/4	19.0496	44.4491	69.8487	95.2482	120.647	146.047	171.446	196.846	222.245	247.645	273.045	298.444	323.844
49/64	19.4465	44.8460	70.2455	95.6451	121.044	146.444	171.843	197.243	222.642	248.042	273.441	298.841	324.241
25/32	19.8433	45.2429	70.6424	96.0419	121.441	146.841	172.240	197.640	223.039	248.439	273.838	299.238	324.638
51/64	20.2402	45.6397	71.0393	96.4398	121.838	147.237	172.637	198.037	223.436	248.836	274.235	299.635	325.035
13/16	20.6371	46.0366	71.4362	96.8357	122.235	147.634	173.034	198.433	223.883	249.232	274.632	300.032	325.431
53/64	21.0339	46.4335	71.8330	97.2326	122.632	148.031	173.431	198.830	224.230	249.629	275.029	300.428	325.828
27/32	21.4308	46.8303	72.2299	97.6294	123.029	148.428	173.828	199.227	224.627	250.026	275.426	300.825	326.225
55/64	21.8277	47.2272	72.6267	98.0263	123.425	148.825	174.224	199.624	225.024	250.423	275.823	301.222	326.622
7/8	22.2245	47.6241	73.0236	98.4232	123.822	149.222	174.621	200.021	225.420	250.820	276.220	301.619	327.019
57/64	22.6214	48.0209	73.4205	98.8200	124.219	149.619	175.018	200.418	225.817	251.217	276.616	302.016	327.415
29/32	23.0183	48.4178	73.8173	99.2169	124.616	150.016	175.415	200.815	226.214	251.614	277.013	302.413	327.812
59/64	23.4151	48.8147	74.2142	99.6137	125.013	150.412	175.812	201.211	226.611	252.011	277.410	302.810	328.209
15/16	23.8120	49.2116	74.6111	100.011	125.410	150.809	176.209	201.608	227.008	252.407	277.807	303.207	328.606
61/64	24.2089	49.6084	75.0080	100.408	125.807	151.206	176.606	202.005	227.405	252.804	278.204	303.603	329.003
31/32	24.6057	50.0053	75.4048	100.804	126.203	151.603	177.003	202.402	227.802	253.201	278.601	304.000	329.400
63/64	25.0026	50.4021	75.8017	101.201	126.600	152.000	177.399	202.799	228.198	253.598	278.998	304.397	329.797

DECIMAL EQUIVALENTS OF MILLIMETERS.

	0	1	2	3	4	5	6	7	8	9
	0.0000	.0394	.0787	.1181	.1575	.1969	.2362	.2756	.3150	.3543
1	.3937	.4331	.4724	.5118	.5512	.5906	.6299	.6693	.7087	.7480
2	.7874	.8268	.8661	.9055	.9449	.9843	1.0236	1.0630	1.1024	1.1417
3	1.1811	1.2205	1.2598	1.2992	1.3386	1.3780	1.4173	1.4567	1.4961	1.5354
4	1.5748	1.6142	1.6536	1.6929	1.7323	1.7717	1.8110	1.8504	1.8898	1.9292
5	1.9685	2.0079	2.0472	2.0866	2.1260	2.1653	2.2047	2.2441	2.2834	2.3228
6	2.3622	2.4016	2.4409	2.4803	2.5197	2.5591	2.5984	2.6378	2.6772	2.7165
7	2.7560	2.7953	2.8346	2.8740	2.9134	2.9528	2.9921	3.0315	3.0709	3.1102
8	3.1497	3.1890	3.2284	3.2677	3.3071	3.3465	3.3858	3.4252	3.4646	3.5040
9	3.5434	3.5827	3.6221	3.6614	3.7008	3.7402	3.7795	3.8189	3.8583	3.8977
10	3.9371	3.9764	4.0158	4.0551	4.0945	4.1339	4.1733	4.2126	4.2520	4.2914
11	4.3308	4.3701	4.4095	4.4488	4.4882	4.5276	4.5670	4.6063	4.6457	4.6851
12	4.7245	4.7638	4.8032	4.8426	4.8819	4.9213	4.9607	5.0000	5.0394	5.0788
13	5.1182	5.1575	5.1969	5.2363	5.2756	5.3150	5.3544	5.3937	5.4331	5.4725
14	5.5119	5.5512	5.5906	5.6300	5.6693	5.7087	5.7481	5.7874	5.8268	5.8662
15	5.9056	5.9450	5.9843	6.0237	6.0631	6.1024	6.1418	6.1812	6.2205	6.2599
16	6.2993	6.3386	6.3780	6.4174	6.4568	6.4961	6.5355	6.5749	6.6142	6.6536
17	6.6930	6.7324	6.7717	6.8111	6.8505	6.8898	6.9292	6.9686	7.0079	7.0473
18	7.0867	7.1261	7.1654	7.2048	7.2442	7.2835	7.3229	7.3623	7.4017	7.4410
19	7.4805	7.5198	7.5591	7.5985	7.6379	7.6773	7.7166	7.7560	7.7954	7.8347
20	7.8742	7.9135	7.9528	7.9922	8.0316	8.0710	8.1103	8.1497	8.1891	8.2284
21	8.2677	8.3072	8.3466	8.3859	8.4253	8.4647	8.5040	8.5434	8.5828	8.6221
22	8.6614	8.7009	8.7403	8.7796	8.8190	8.8584	8.8977	8.9371	8.9765	9.0158
23	9.0553	9.0946	9.1340	9.1733	9.2127	9.2521	9.2915	9.3308	9.3702	9.4096
24	9.4490	9.4883	9.5277	9.5670	9.6064	9.6458	9.6852	9.7245	9.7639	9.8033
25	9.8427	9.8820	9.9214	9.9608	10.0000	10.0395	10.0789	10.1182	10.1576	10.1970
26	10.2364	10.2757	10.3151	10.3545	10.3938	10.4332	10.4726	10.5119	10.5513	10.5907
27	10.6301	10.6694	10.7088	10.7482	10.7875	10.8269	10.8663	10.9057	10.9450	10.9844
28	11.0238	11.0631	11.1025	11.1419	11.1813	11.2206	11.2600	11.2994	11.3387	11.3781
29	11.4175	11.4568	11.4962	11.5356	11.5750	11.6143	11.6537	11.6931	11.7324	11.7718
30	11.8112	11.8506	11.8899	11.9293	11.9687	12.0080	12.0474	12.0868	12.1261	12.1655
31	12.2049	12.2443	12.2836	12.3230	12.3624	12.4017	12.4411	12.4805	12.5199	12.5592
32	12.5986	12.6380	12.6773	12.7167	12.7561	12.7955	12.8348	12.8742	12.9136	12.9529
33	12.9923	13.0317	13.0711	13.1104	13.1498	13.1892	13.2285	13.2679	13.3073	13.3466
34	13.3860	13.4254	13.4648	13.5041	13.5435	13.5829	13.6222	13.6616	13.7010	13.7403
35	13.7797	13.8191	13.8585	13.8978	13.9372	13.9766	14.0159	14.0553	14.0947	14.1341
36	14.1734	14.2128	14.2522	14.2915	14.3309	14.3703	14.4097	14.4490	14.5884	14.5278
37	14.5671	14.6065	14.6459	14.6851	14.7246	14.7640	14.8034	14.8427	14.8821	14.9215
38	14.9607	15.0002	15.0396	15.0790	15.1183	15.1577	15.1971	15.2364	15.2758	15.3152
39	15.3546	15.3939	15.4333	15.4727	15.5120	15.5514	15.5908	15.6301	15.6695	15.7089
40	15.7483	15.7876	15.8270	15.8664	15.9057	15.9451	15.9845	16.0237	16.0632	16.1026
41	16.1420	16.1813	16.2207	16.2601	16.2993	16.3388	16.3782	16.4176	16.4569	16.4963
42	16.5357	16.5751	16.6144	16.6538	16.6932	16.7325	16.7719	16.8113	16.8506	16.8900
43	16.9294	16.9688	17.0081	17.0475	17.0869	17.1262	17.1656	17.2050	17.2443	17.2837
44	17.3231	17.3625	17.4018	17.4412	17.4806	17.5199	17.5593	17.5987	17.6381	17.6774
45	17.7168	17.7562	17.7955	17.8349	17.8743	17.9137	17.9530	17.9924	18.0318	18.0711
46	18.1105	18.1499	18.1893	18.2286	18.2679	18.3074	18.3467	18.3861	18.4253	18.4648
47	18.5042	18.5436	18.5830	18.6223	18.6617	18.7011	18.7404	18.7798	18.8192	18.8586
48	18.8979	18.9373	18.9767	19.0160	19.0554	19.0948	19.1341	19.1735	19.2129	19.2523
49	19.2916	19.3310	19.3704	19.4097	19.4491	19.4885	19.5279	19.5672	19.6066	19.6460

Decimal Equivalents of Fractions of Millimeters for use with Metric Micrometer Calipers.

(From Catalogue of Brown & Sharpe Mfg. Co.)

mm.	*Inches.*	*mm.*	*Inches.*
$\frac{1}{50}$ =	.00079	$\frac{26}{50}$ =	.02047
$\frac{2}{50}$ =	.00157	$\frac{27}{50}$ =	.02126
$\frac{3}{50}$ =	.00236	$\frac{28}{50}$ =	.02205
$\frac{4}{50}$ =	.00315	$\frac{29}{50}$ =	.02283
$\frac{5}{50}$ =	.00394	$\frac{30}{50}$ =	.02362
$\frac{6}{50}$ =	.00472	$\frac{31}{50}$ =	.02441
$\frac{7}{50}$ =	.00551	$\frac{32}{50}$ =	.02520
$\frac{8}{50}$ =	.00630	$\frac{33}{50}$ =	.02598
$\frac{9}{50}$ =	.00709	$\frac{34}{50}$ =	.02677
$\frac{10}{50}$ =	.00787	$\frac{35}{50}$ =	.02756
$\frac{11}{50}$ =	.00866	$\frac{36}{50}$ =	.02835
$\frac{12}{50}$ =	.00945	$\frac{37}{50}$ =	.02913
$\frac{13}{50}$ =	.01024	$\frac{38}{50}$ =	.02992
$\frac{14}{50}$ =	.01102	$\frac{39}{50}$ =	.03071
$\frac{15}{50}$ =	.01181	$\frac{40}{50}$ =	.03150
$\frac{16}{50}$ =	.01260	$\frac{41}{50}$ =	.03228
$\frac{17}{81}$ =	.01339	$\frac{42}{50}$ =	.03307
$\frac{18}{50}$ =	.01417	$\frac{43}{50}$ =	.03386
$\frac{19}{50}$ =	.01496	$\frac{44}{50}$ =	.03465
$\frac{20}{50}$ =	.01575	$\frac{45}{50}$ =	.03543
$\frac{21}{50}$ =	.01654	$\frac{46}{50}$ =	.03622
$\frac{22}{50}$ =	.01732	$\frac{47}{50}$ =	.03701
$\frac{23}{50}$ =	.01811	$\frac{48}{50}$ =	.03780
$\frac{24}{50}$ =	.01890	$\frac{49}{50}$ =	.03858
$\frac{25}{50}$ =	.01969	1 =	.03937

METRIC CONVERSION TABLES.

UNITS OF WEIGHT.

Metric	United States.
1 gram =	15.432 grains.
28.35 grams =	1 ounce avoirdupois.
1 kilogram =	2.2046 lbs. avoirdupois.
.4536 kilograms =	1 lb. avoirdupois.
1 metric ton =	1.1023 tons of 2,000 lbs.
9072 metric ton =	1 ton.

SQUARE MEASURE.

Metric.	United States.
1 square meter =	10.764 square feet.
.0929 square meter =	1 square foot.
1 square centimeter =	.155 square inch.
6.452 square centimeters =	1 square inch.
1 square millimeter =	.00155 square inch.
645.2 square millimeters	1 square inch.

LINEAR MEASURE.

Metric.	United States.
1 meter =	39.37 inches.
	3.28084 feet.
.3048 meter =	1 foot.
1 centimeter =	.3937 inch.
2.54 centimeters =	1 inch.
1 millimeter =	.03937 inch (or .0006 less than $\frac{1}{25}$ of an inch.)
25.4 millimeters =	1 inch.

CUBIC MEASURE.

Metric.	United States.
1 cubic meter =	35.314 cubic feet.
.02832 cubic meters =	1 cubic foot.
1 cubic centimeter =	.061 cubic inch.
16.387 cubic centimeters =	1 cubic inch.
1 liter =	.2641 gallons.
3.7868 liters =	1 gallon.
1 liter =	.0353 cubic feet.
28.317 liters =	1 cubic foot

MISCELLANEOUS TABLE.

1 kilogram per square centimeter =	14.2232 pounds per square inch.
.07031 kilogram per square centimeter =	1 pound per square inch
1 kilogram-meter =	7.233 foot-pounds.
.13826 kilogram-meter =	1 foot-pound.
1 calorie =	3.9683 British thermal units.
.252 calorie =	1 British thermal unit.
1 force de cheval.	98632 horse-power.
1.0139 force de cheval =	1 horse-power

The following note by Mr. C. C. Stutz, relative to the unit of "pound per square inch" and its metric equivalent will illustrate the derivation and use of compound units:

In the English system the strength of materials is indicated in lbs. per square inch, and in the metric system in kilograms per square centimeter.

To transform one term into the other the co-efficient 14.223 is used as follows:

Kg. per sq. cm. × 14.223 = lbs. per sq. in.; lbs. per sq. in. ÷ 14.223 = kg. per sq. cm.

Derivation of the coefficient: 1 inch = 2.54 cm.; 1 sq. inch = 2.54^2 = 6.4516 sq. cm; 1 kg. = 2.2046 lbs; 6.4516 × 2.2046 = 14.223197.

Miscellaneous Tables

On pages 26 and 27 tables are given for ordinary wrenches. The table on page 26 is made up to conform to the standards adopted by the Engineering Standards Committee (Great Britain). On page 29 a table is given of box wrenches. On pages 30 and 31 are given tables of standard automobile details according to the standards adopted by the Association of Licensed Automobile Manufacturers. These tables include dimensions for standard solid yoke and eye-rod ends, standard pin and washer dimensions, standard spark plugs and standard adjustable yoke and eye-rod ends.

On page 32 a table is given of diameters of blanks for drawn shells from ¼ x ¼ to 6 x 6 inches. When the diameter of the shell and its height are given the diameter of the required blank may be found in the body of the table. For example, assume that the diameter of the shell is to be 1½ inch and the height of the shell 2 inches. By locating the diameter in the left-hand column, and the given height at the top, and following the horizontal line from the diameter until we reach the figure in the column headed by the height, we find that the diameter of the required blank is 3.78 inches.

On page 33 dimensions are given for standard soft steel rope sockets with pin. This table will be found convenient by designers who may occasionally be required to lay out a steel rope socket.

Drafting-room Conventions

On pages 34 to 37, inclusive, are shown a number of common drafting-room conventions. Of course, practice differs considerably in different drafting-rooms, but the methods shown indicate average practice. Conventional forms for cross-sectioning for indicating materials and for representing breaks are shown on page 34. Conventions for screws and screw threads of different types are shown on page 35, and for pipe fittings and riveting on page 36. The conventions shown on page 37 are the standard conventions required on the United States Patent Office drawings. [MACHINERY'S Reference Series No. 2, Drafting-room Practice; No. 8, Working Drawings and Drafting-room Kinks; No. 33, Systems and Practice of the Drafting-room.]

Conversion Tables

On page 38 tables are given of decimal equivalents of fractions of an inch, and on page 39 decimal equivalents of a foot corresponding to inches and fractions of inches from 0 to 12. Assume, for example, that it is required to find the equivalent of 6 7/32 inches in decimals of a foot. Locate 7/32 in the left-hand column and follow the horizontal line until the column headed "6" is reached. The figures 5182 read off in this column are the decimals of a foot corresponding to 6 7/32, or, in other words, 6 7/32 inches equals 0.5182 foot.

On pages 40 and 41 tables are given for converting inches and fractions of inches into millimeters. Assume, for example, that it is required to find the equivalent of 5¼ inches in millimeters. On page 40, locate 1/4 in the left-hand column and follow the horizontal line until the column headed "5" is reached. The value 133.347 is the equivalent of 5 1/4 inches in millimeters, or, in other words, 5 1/4 inches equals 133.347 millimeters.

On page 42 a table is given for converting millimeters into inches. Assume that it is required to convert 152 millimeters into inches. Locate the two first figures, "15," in the left-hand column and follow the horizontal line until the column headed "2" is reached. The value read off in this column, 5.9843, is the equivalent in inches of 152 millimeters, or, in other words, 152

(Continued on page 48.)

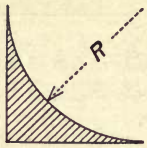
SPECIFIC GRAVITY AND PROPERTIES OF METALS

Metal or Composition	Chemical Symbol	Specific Gravity	Weight per Cubic Inch, Pounds	Weight per Cubic Foot, Pounds	Melting Point, Deg. F.	Structure *	Linear Expansion per Unit Length per Deg. F.	Electric Conductivity; Silver = 100	Approx. Value per Pound, Dollars
Aluminum	Al	2.56	0.0924	159.7	1200	M	0.00001234	63.00	0.34
Antimony	Sb	6.71	0.2422	418.7	1150	B	0.00000627	3.59	0.23
Barium	Ba	3.75	0.1354	234.0	1560	M	.....	30.61	512.00
Bismuth	Bi	9.80	0.3538	611.5	500	B	0.00000975	1.40	1.60
Boron	B	2.60	0.0939	162.2	.....	H	.....	.....	270.00
Brass—									
80 C., 20 Z.	.....	8.60	0.3105	536.6	1700 to 1850	M	0.00000957	.....	0.15
70 C., 30 Z.	.....	8.40	0.3032	524.1				.....	0.14
60 C., 40 Z.	.....	8.36	0.3018	521.7				.....	0.13
50 C., 50 Z.	.....	8.20	0.2960	511.6				.....	0.12
Bronze	.....	8.85	0.3195	552.2	1675	B	0.00000986	.....	0.20
Cadmium	Cd	8.60	0.3105	536.6	550	M	.....	24.38	1.60
Calcium	Ca	1.57	0.0567	98.0	1450	M	.....	21.77	1080.00
Chromium	Cr	6.50	0.2347	405.6	3500	B	.....	16.00	0.80
Cobalt	Co	8.65	0.3123	539.8	2800	M	.....	16.93	1.60
Copper	Cu	8.82	0.3184	550.4	1940	M	0.00000887	97.67	0.15
Gold	Au	19.32	0.6975	1205.6	1930	M	0.00000786	76.71	320.00
Iridium	Ir	22.42	0.8094	1399.0	3980	M	0.00000356	13.52	160.00
Iron, cast	Fe	7.20	0.2600	449.2	2300	B	0 00000556	.....	0.01
Iron, wrought	Fe	7.85	0.2834	489.8	2900	M	0.00000648	16.80	0 02
Lead	Pb	11.37	0.4105	709.5	620	S	0.00001571	8.42	0.06
Magnesium	Mg	1.74	0.0628	108.6	1200	M	.....	39.44	1.50
Manganese	Mn	7.42	0.2679	463.0	3450	B	.....	15.75	0.70
Mercury (60° F.)	Hg	13.58	0.4902	847.4	—39	F	.....	1.75	0.55
Molybdenum	Mo	8.56	0.3090	534.2	.....	B	.....	17.60	1.10
Nickel	Ni	8.80	0.3177	549.1	2700	M	0.00000695	12.89	0.45
Platinum, rolled	Pt	22.67	0.8184	1414.6	3200	M	0.00000479	14.43	400.00
Platinum, wire	Pt	21.04	0.7595	1312.9					
Potassium	K	0.87	0.0314	54.3	144	S	.....	19.62	3.20
Silver	Ag	10.53	0.3802	657.1	1740	M	0.00001079	100.00	10.40
Sodium	Na	0.98	0 0354	61.1	200	S	.....	31.98	3.20
Steel	Fe	7.80	0.2816	486.7	2500	M	0.00000636	12.00	.....
Tellurium	Te	6.25	0.2256	390.0	900	B	.....	0.001	80.00
Tin	Sn	7.29	0.2632	454.8	446	M	0.00001163	14.39	0.40
Titanium	Ti	3.54	0.1278	220.9	.....	M	.....	13.73	800.00
Tungsten	W	18.77	0.6776	1171.2	3500	B	.....	14.00	0.64
Vanadium	V	5.50	0.1986	343.2	3200	M	.....	4.95	1080.00
Zinc, cast	Zn	6.86	0.2476	428.1	785	B	0.00001407	29.57	0.06
Zinc, rolled	Zn	7.15	0.2581	446.1		M			

* B = brittle; F = fluid; H = hard; M = malleable; S = soft.

Explanatory note: Page 48.

AREAS AND WEIGHTS OF FILLETS OF STEEL, CAST IRON, AND BRASS—I



Calculations are based on the following weights.
Steel ..... 489.6 lbs. per Cubic Foot.
Cast Iron ..... 450 " " " "
Cast Brass ..... 504 " " " "

Radius R.	Area	Weight of Steel		Weight of Cast Iron		Weight of Cast Brass	
		per foot	per inch	per foot	per inch	per foot	per inch
1/16	.0008	.0029	.00024	.0026	.00022	.0029	.00025
1/8	.0033	.0115	.00096	.0106	.0009	.0118	.0010
3/16	.0075	.0255	.0021	.0235	.0019	.0263	.0022
1/4	.0134	.0455	.0038	.0418	.0035	.0469	.0040
5/16	.0209	.0712	.0059	.0655	.0054	.0733	.0061
3/8	.0302	.1027	.0085	.0945	.0078	.1058	.0088
7/16	.0411	.1397	.0116	.1285	.0107	.1439	.0120
1/2	.0536	.1825	.0152	.1679	.0140	.1880	.0157
9/16	.0679	.2310	.0192	.2125	.0177	.2380	.0200
5/8	.0834	.2847	.0237	.2619	.0218	2932	.0244
11/16	.1014	.3447	.0287	.3171	.0264	.3550	.0300
3/4	.1207	.4105	.0342	.3777	.0315	.4228	.0352
13/16	.1416	.4817	.0401	.4432	.0369	.4962	.0414
7/8	.1643	.5580	.0465	.5134	.0428	.5747	.0479
15/16	.1886	.6405	.0534	.5893	.0491	.6597	.0550
1	.2146	.7300	.0608	.6716	.0559	.7519	.0626
1 1/8	.2716	.9250	.0771	.8510	.0709	.9527	.0794
1 1/4	.3353	1.140	.0950	1.049	.0874	1.174	.0979
1 3/8	.4057	1.200	.1000	1.104	.0920	1.236	.1030
1 1/2	.4828	1.642	.1368	1.511	.1259	1.691	.1410

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AREAS AND WEIGHTS OF FILLETS—II

Radius R.	Area	Weight of Steel		Weight of Cast Iron		Weight of Cast Brass	
		per foot	per inch	per foot	per inch	per foot	per inch
1 5/8	.5668	1.930	.1608	1.776	.1479	1.988	.1657
1 3/4	.6572	2.235	.1862	2.056	.1713	2.302	.1920
1 7/8	.7545	2.565	.2137	2.360	.1970	2.642	.2202
2	.8585	2.917	.2431	2.684	.2237	3.005	.2504
2 1/8	.9692	3.292	.2743	3.029	.2502	3.391	.2826
2 1/4	1.086	3.695	.3079	3.399	.2832	3.806	.3172
2 3/8	1.210	4.115	.3429	3.786	.3155	4.238	.3532
2 1/2	1.341	4.560	.3800	4.195	.3496	4.697	.3914
2 5/8	1.478	5.030	.4192	4.628	.3857	5.181	.4317
2 3/4	1.623	5.507	.4589	5.066	.4222	5.672	.4727
2 7/8	1.774	6.027	.5022	5.545	.4621	6.208	.5017
3	1.931	6.565	.5471	5.940	.4950	6.762	.5635
3 1/8	2.096	7.125	.5937	6.555	.5462	7.339	.6116
3 1/4	2.267	7.700	.6417	7.084	.5903	7.931	.6609
3 3/8	2.444	8.300	.6917	7.636	.6363	8.549	.7124
3 1/2	2.629	8.925	.7438	8.211	.6926	9.193	.7661
3 5/8	2.820	9.575	.7979	8.809	.7341	9.862	.8220
3 3/4	3.018	10.27	.8523	9.448	.7873	10.58	.8817
3 7/8	3.222	10.97	.9142	10.09	.8408	11.30	.9417
4	3.434	11.65	.9709	10.72	.8933	12.00	1.000
4 1/8	3.652	12.40	1.033	11.41	.9508	12.77	1.064
4 1/4	3.876	13.15	1.096	12.10	1.008	13.54	1.130
4 3/8	4.107	13.97	1.164	12.85	1.071	14.39	1.199
4 1/2	4.346	14.77	1.231	13.59	1.132	15.21	1.270
4 5/8	4.590	15.60	1.300	14.35	1.196	16.07	1.340
4 3/4	4.842	16.45	1.371	15.13	1.261	16.94	1.412
4 7/8	5.100	17.32	1.444	15.93	1.328	17.84	1.487
5	5.365	18.25	1.521	16.79	1.400	18.80	1.570

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millimeters equals 5.9843 inches. If the equivalent of 6 millimeters is required, the value is read off in the top line of the table in the column headed "6"; hence, 6 millimeters is found to equal 0.2362 inches. By arranging the table in the manner shown, it is possible to make it more compact and to include the values in inches corresponding to all whole numbers up to and including 499 millimeters.

On page 43 a metric conversion table is given including weight, linear measure, square measure, and cubic measure. A miscellaneous table is also given for the conversion of compound units.

Specific Gravity

The expression "specific gravity" indicates how many times a certain volume of a material is heavier than an equal volume of water. If it is found, for example, that one cubic inch of steel weighs 7.8 times as much as one cubic inch of pure water, the specific gravity of steel is 7.8. As the density of water differs slightly at different temperatures, it is usual to make comparisons on the basis that the water has a temperature of 62 degrees F. The weight of one cubic inch of pure water at 62 degrees F. is 0.0361 pound. If the specific gravity of any material is known, the weight of a cubic inch of the material can, therefore, be found by multiplying its specific gravity by 0.0361. The specific gravity of cast iron, for example, is 7.2. The weight of one cubic inch of cast iron is found by multiplying 7.2 by 0.0361. The product, 0.260, is the weight of one cubic inch of cast iron.

If the weight of a cubic inch of a material is known, the specific gravity is found by dividing the weight per cubic inch by 0.0361. The weight of a cubic inch of gold is 0.697 pound. The specific gravity of gold is then found by dividing 0.697 by 0.0361. The quotient, 19.32, is the specific gravity of gold.

On page 45 a table is given of specific gravity, weight per cubic inch, weight per cubic foot, etc., of metals. [MACHINERY'S Reference Series No. 52, Advanced Shop Arithmetic for the Machinist, Chapter X, Specific Gravity and Weights of Bar Stock and Castings.]

Areas and Weights of Fillets

In estimating the weight of a casting it is not usual to make any allowance for fillets and round corners. They generally are so small as to not make much difference in the final result, and are quite likely to balance each other as well. That is to say, the weight that would have to be added if the fillet were taken into account will ordinarily just about balance that which would have to be subtracted if the rounding of the corners were considered. In castings, however, where rounds of large radii are used either for corners or edges it often becomes necessary to take them into account.

On pages 46 and 47 a table of the areas and weights of fillets of steel, cast iron and brass is given. This table has been computed in order to make it easy to calculate the weight of castings having large fillets. If the radius of the fillet, for example, equals ¼ inch, then the area of the fillets is 0.0134 square inch, and if made of cast iron, the weight per inch length of a fillet of this area is 0.0035 pound. If the fillet is part of a straight piece it is only necessary to multiply the total length of the fillet by the value just obtained, in order to obtain the total weight. If the fillet is part of a cylindrical piece, it is necessary to find the mean radius, or the radius of the center of gravity of the fillet section, and to calculate the circumference of the circle passing through this center of gravity. The length of this circumference multiplied by the weight per inch or per foot then gives the total weight. [MACHINERY, July, 1906, Estimating Weights of Fillets and Round Corners.]

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